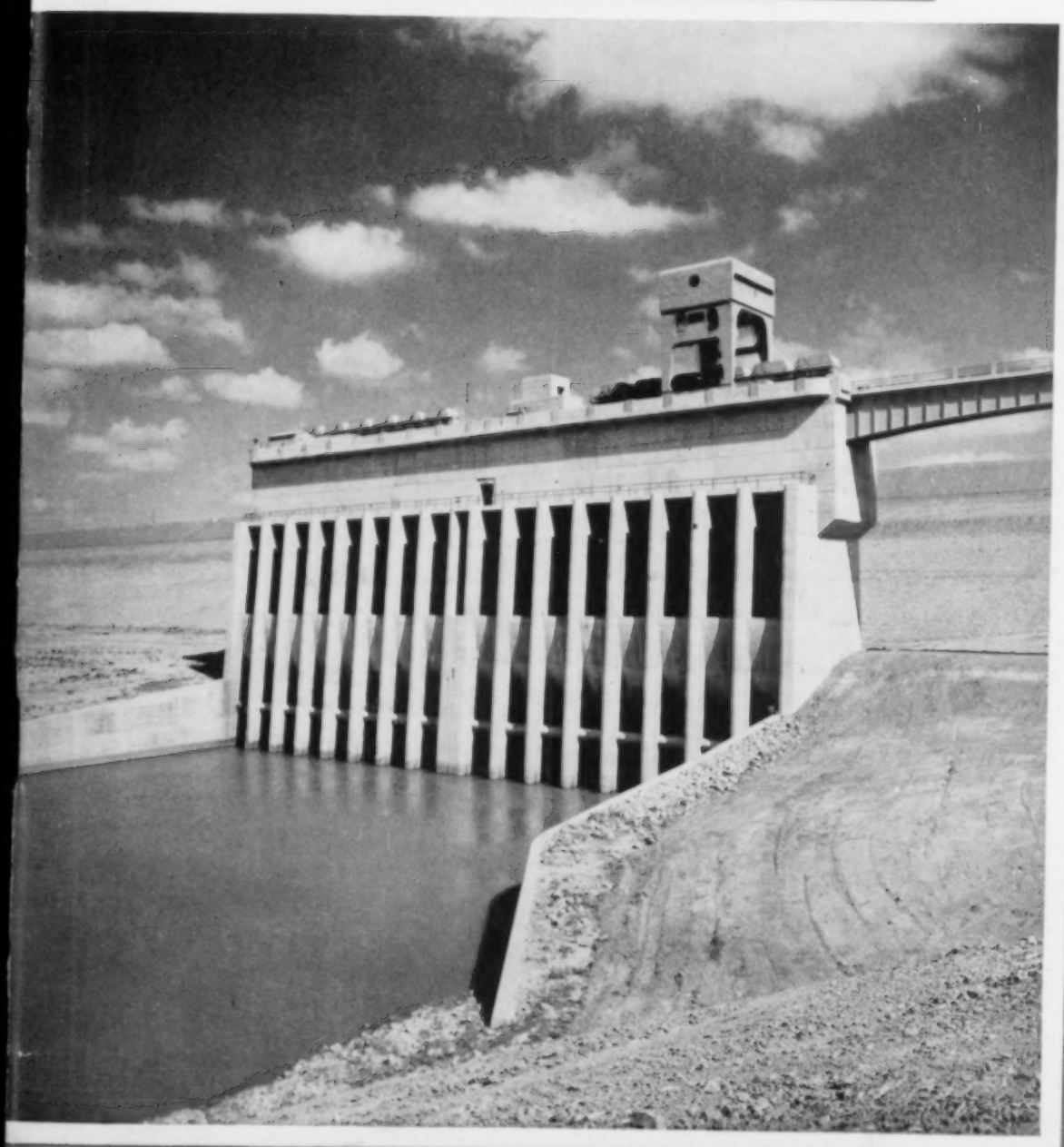
Compressed Air Magazine

MAY 1944



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VOLUME 49 • NUMBER 5

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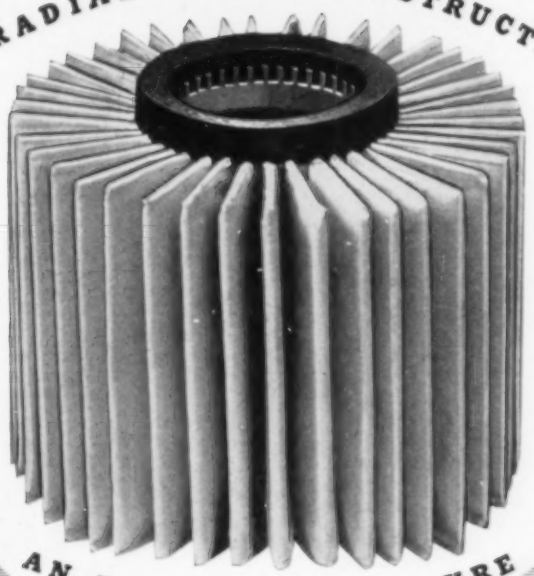

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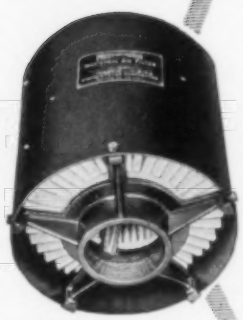

MODEL D
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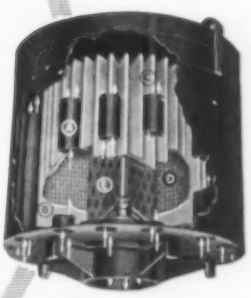

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MODEL CPH
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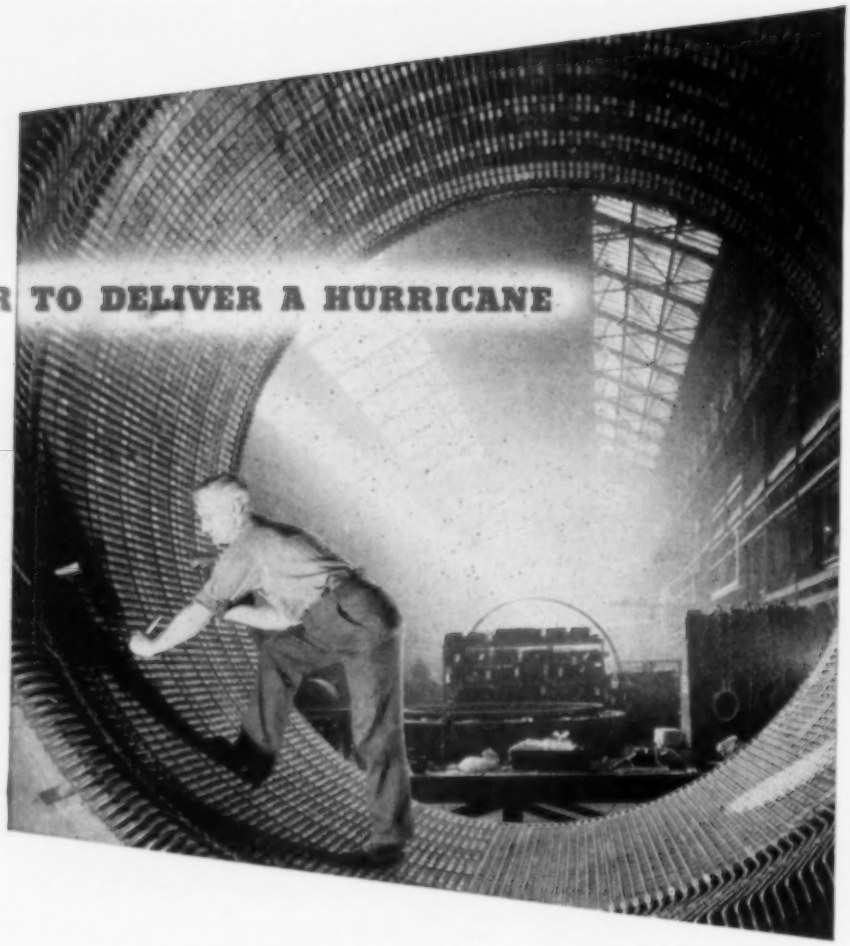

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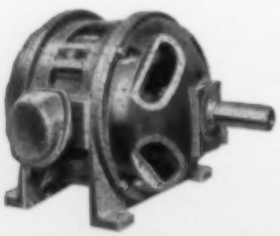

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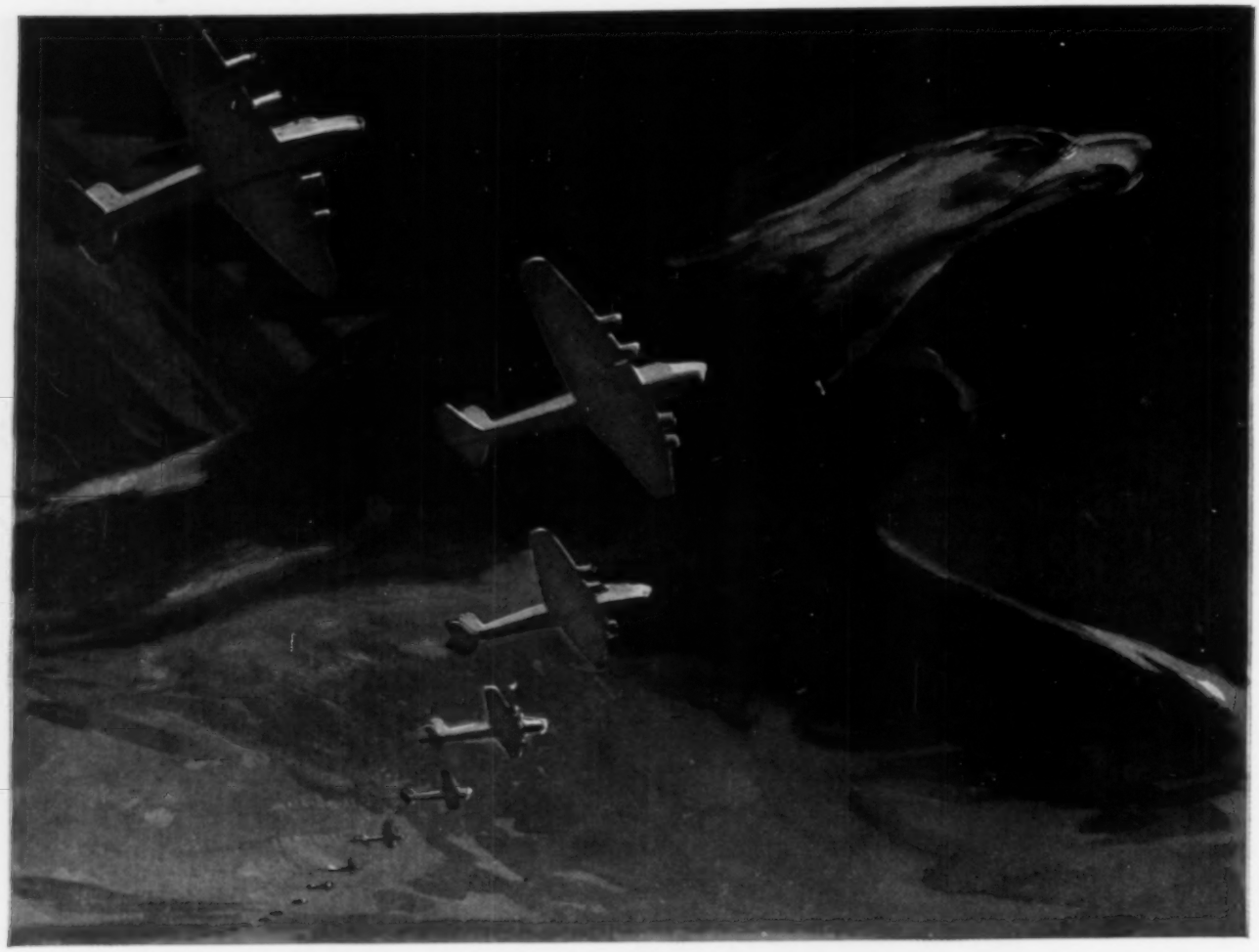

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is essential to continuous operation. Manpower shortages and interrupted service due to maintenance were reduced by a large lead-zinc mine that operated a Model 21 Eimco RockerShovel underground 2 shifts a day, 6 days a week, for 46 months before bringing it to the surface for a mechanical check-up. That's the "Staying Power" of the

Eimco RockerShovel

What is "Staying Power"? The mechanical check-up by this mine gave the answer. All gears and working parts showed practically no wear—heavy alloy steel castings throughout, no breakage or cracks; massive patented Rocker Arms and over-all rugged construction meant the RockerShovel could be taken underground for further months of continuous tough service without interruption due to mechanical failure. But in addition to "Staying Power," the Eimco RockerShovel offers ease of operation, surplus energy, and speed. Its simplicity of design, made possible by its rocker arms and other patents, assure freedom from troublesome gadgets.

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MAXIMUM DIGGING FORCE

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Patented Rocker-Arm Profile causes bucket to move forward as well as upward while digging into muck pile, thereby reducing the amount of "crowding" required to fill the bucket and assuring a full bucket every time.

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ON THE COVER

THIS symmetrical mass of concrete rises in the reservoir area just upstream from the main embankment of Denison Dam, a section of which is visible. On its operating deck, 130 feet above the foundation, are individual hoists and a traveling crane that control service gates and emergency gates at the base of the structure for the admission of water to the conduits. The latter carry the outflow underneath the dam, five of them being designed for power generation and three for flood control. When the reservoir is filled to operating level, all but the upper 33 feet of the structure shown will be underwater. At the right is a part of the 300-foot access bridge that extends from high ground which formed the original river bank. The dam is near Denison, Tex., on the Red River, which is the boundary between Texas and Oklahoma.

•

IN THIS ISSUE

IN ORDINARY times, much would have been written about Denison Dam, a flood-control and power-generation, rolled-fill earth structure of record size that has been under construction for four years. However, military censorship and the overshadowing importance of war projects have kept the engineering press from devoting much attention to it. We are privileged to publish what is perhaps the first comprehensive description of the great barrier that has been built under the supervision of the Corps of Engineers, U.S. Army.

•

THE article by Maj. Gen. Eugene Reybold on construction in the various theaters of war gives us additional interesting information on the important work U.S. Army Engineers are doing to pave the way for our fighting men.

•

PRACTICAL information on the use of pneumatic tools and equipment in marine-salvage operations is contained in an article by R.G. Skerrett that is more or less a follow-up of his previous writings on the rehabilitation of our blasted fleet at Pearl Harbor and the raising of the sunken *Normandie*.

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A SHORT article tells us how naval stores are protected from fire with carbon-dioxide gas, and another describes a transandean highway in Peru.

Compressed Air Magazine

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The Denison Dam

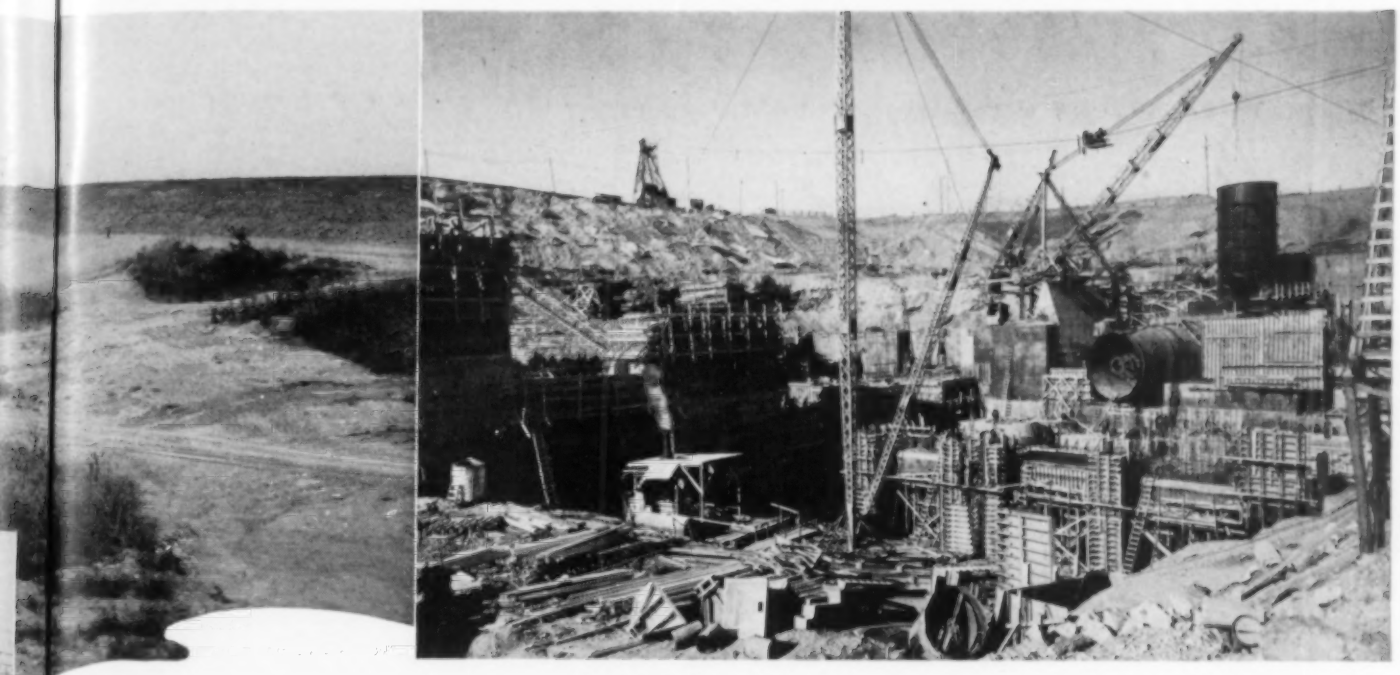
GENERAL VIEWS

At the top is a view along the upstream face of the dam taken from the Texas end and showing the intake structure of the outlet works at the left. At the bottom are pictured 20-ton trailer trucks delivering fill material during the building up of the huge embankment. The spillway (center), which is at the south end of the dam and at an angle to it, is surmounted by a concrete weir 2000 feet long. Downstream of the weir is a paved chute section which is seen here in course of construction. The powerhouse foundation goes down nearly 50 feet below the level of the former riverbed. The picture on the next page shows the structure as it looked in April, 1943. Note the overhead construction cableway that was used.

C. H. Vivian

AFTER more than four years of work, the Denison Dam across the Red River near Denison, Tex., is approaching completion under the supervision of the Corps of Engineers, U. S. Army. Although it is the largest rolled-filled earth dam ever built in the United States, it has received little publicity outside its immediate area because it was constructed during a period of national emergency. Among all American-built earth dams it ranks fourth in size. Larger ones are the Fort Peck in Montana, the Kingsley in Nebraska, and the Gatun in Panama. But all these structures were reared by the hydraulic-fill method. Denison Dam contains 18,385,000 cubic yards of earth, all of which was excavated, hauled to the site, spread, scarified, sprinkled, and rolled. Until it was built, Hansen Dam in California, with 14,000,000 cubic yards of earth, held the record as our largest rolled-filled earth dam.

The Denison Dam project will cost ap-



proximately $54,000,000. It was authorized by Congress in 1938 and was designed primarily to control floods in the Red River, which drains sections of Texas, Oklahoma, Arkansas, and Louisiana before it empties into the Mississippi above Baton Rouge. The watershed above the dam covers 38,290 square miles, or about 40 percent of the stream's total drainage area. The river flow at the dam site has varied from 85 to 470,000 second-feet. The second purpose of the development is hydroelectric-power generation. One 35,000-kw. generator is now being put in place, and space is available for a second one. Provision has also been made for the extension of the powerhouse and the installation of three additional units in the future.

The Red River forms the boundary between Texas and Oklahoma, so the dam is in both states. A short distance upstream from its site, the Washita flows into the Red from the north, on the Oklahoma side. The reservoir will consequently back up in both the Red and Washita basins. It will extend up the Red 80 river miles to a point close to Gainesville, Tex., and up the Washita 60 river miles to near Ravia, Okla. At spillway level it will have a shore line of 1600 miles, a surface area of 145,500 acres, and a maximum depth of 130 feet. At normal pool elevation the surface area will be 95,000 acres. The reservoir storage capacity is 5,825,000 acre-feet of which 2,745,000 acre-feet has been allocated to flood control, 2,060,000 acre-feet to power generation, and 1,020,000 acre-feet to silt deposition.

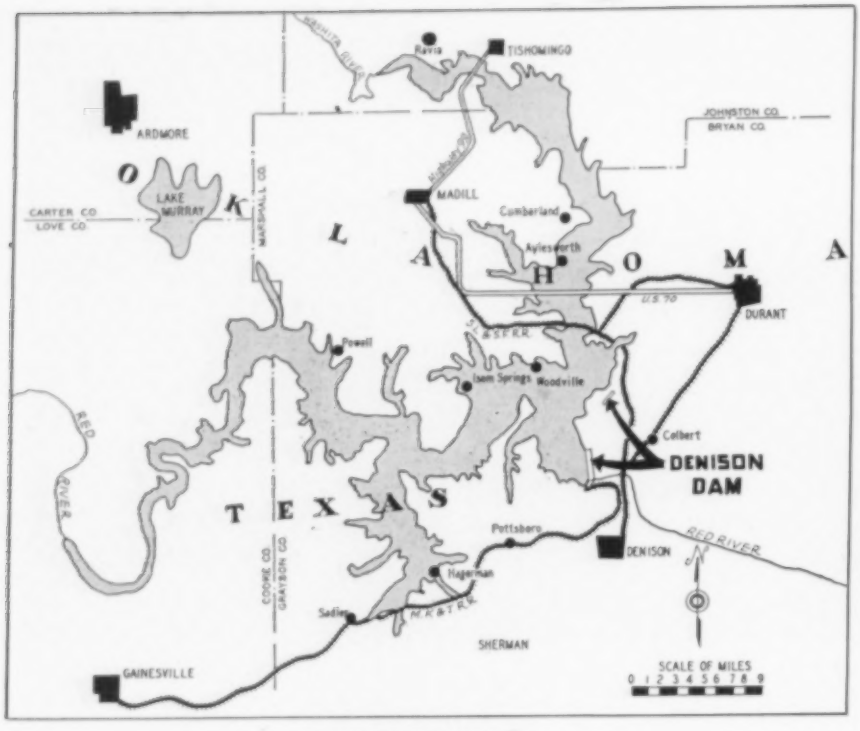
Denison Dam proper consists of four major items of construction: a main-dam embankment, a spillway, outlet works, and a power plant. The main embankment is 16,000 feet long, has a maximum base thickness of 2000 feet, and a maximum height of 160 feet above the streambed. It lies almost due north and south; and at its southern end on the Texas side and at an angle of about 45° to the embankment there is a paved spillway surmounted by a concrete weir 2000 feet long. The top of the dam is at Elevation 670 and the spillway crest at Elevation 640.

The outlet works consist of a concrete intake structure and eight concrete conduits, each 20 feet in diameter and 800 feet long, extending downstream underneath the dam. Five of the conduits will carry water for generating power and three will be used for flood control. The normal outflow from the reservoir will be regulated by gates in the intake structure. The powerhouse is at the downstream end of the power conduits and there is a stilling basin at the downstream end of the other conduits. The present power plant contains offices and control rooms adequate for the ultimate, complete installation and represents approximately one-half of the building as it will be eventually. In addition to the main dam, a dike 5800 feet long was reared across a low saddle 3 miles to the north.

The project necessitated relocating 27 miles of rail lines and 16 miles of highways. The St. Louis & San Francisco (Frisco) Railroad between Madill, Okla., and Denison, Tex., with a branch to Durant, Okla., was carried over the Washita River arm of the reservoir on a 5000-foot bridge. This work was done by the Amis Construction Company and Brisco. The Missouri-Kansas-Texas (Katy) line was shifted to higher ground between Pottsboro and Sadler, Tex., by the Gifford-Hill Company. Highway 70 between Madill and Durant, Okla., crosses the reservoir on a mile-long trestle built by the Union Construction Company and Paul B. Reis, while the stretch of Highway 99 between Madill and Tishomingo, Okla., was relocated by the Austin Bridge Company and now crosses the Washita arm of the reservoir near its upstream end.

In connection with the undertaking, the Government acquired 187,500 acres of land. Most of this is in the reservoir area, the clearing of which was started in 1939. The labor of German prisoners of war was used for this purpose in 1943 when it became difficult to get workers. Most of them were members of Rommel's Afrika Korps who were captured during the fighting along the Mediterranean. They came from the provisional internment camp at Madill and were quartered in two camps constructed for them in the area where they were employed. For the most part, they wielded axes and saws in clearing some of the 30,000 acres of woodland involved. Their use was in accord with the terms of the Geneva Convention, and they were paid at the rate of 80 cents a day.

Five towns which would have been inundated by the reservoir were moved in part or in their entirety to higher ground. They are Aylesworth, Woodville, Powell, and Isom Springs, Okla., and Hagerman, Tex., having a combined population of about 900. Approximately 2000 graves also were transferred from several cemeteries. The historic home built by Col. Holland Coffee in 1837 in Grayson County, Texas, was preserved by relocating it above the reservoir high-water line. It was dismantled, and the pieces were marked so that they could be reassembled without difficulty. A trading post, where white captives of the Indians were redeemed a century



LOCATION MAP

The arrows indicate the main-dam embankment and spillway and the small dike 3 miles to the north that closes a gap between two hills. The reservoir will back water up both the Red and Washita rivers. Railroad lines and highways that had to be shifted are shown at approximately their relocated positions. The map also indicates the original locations of five towns that had to be moved from the reservoir area. Not shown are the dikes and channels that were constructed to prevent the flooding of a new oil field brought in near Cumberland, Okla.

ago, and the mausoleum of Colonel Coffee, which was constructed of brick made by hand and fired on the plantation, were likewise moved to a new site provided by Grayson County.

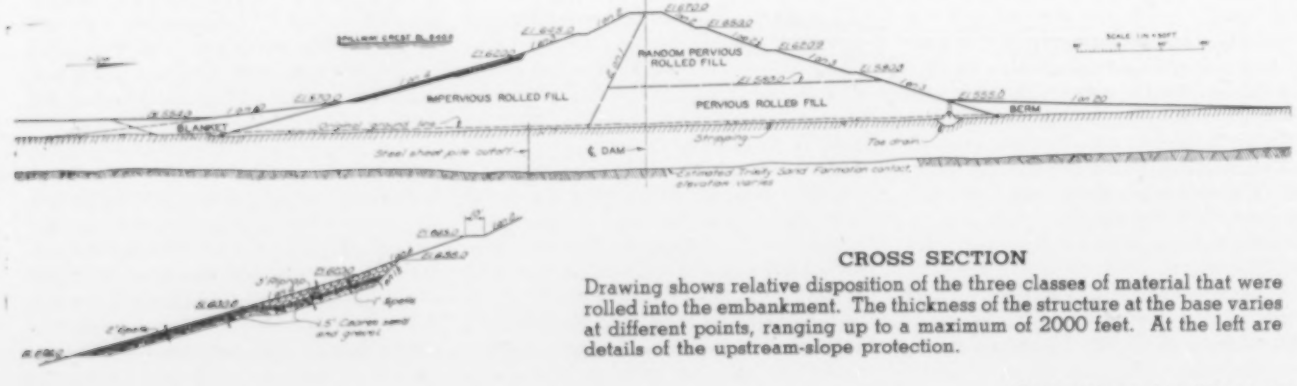
The Coffee manor house, called Glen Eden, was once a rendezvous for people prominent in the affairs of the South. Its mistress, Sophia Suttonfield-Coffee-Butts-Porter, was the four-times-wed daughter of a colonel. As an impetuous girl of sixteen she eloped with an army officer, who deserted her in Texas four years later. After the fall of the Alamo in 1835, while she was fleeing with others before the advancing Mexican forces under Santa Anna, she was protected by the army of Gen. Sam Houston, and it is claimed that she nursed the general after he had been wounded at San Jacinto. During that period she met Colonel Coffee, and they were married after a lapse of two years, with General Houston as one of the guests.

Colonel Coffee built Glen Eden for his bride, and she reigned there as a gracious hostess, Gen. Robert E. Lee and Fitzhugh Lee having been among the many visitors. Colonel Coffee was killed in 1846, and four years later his attractive widow became the wife of Maj. George Butts of Norfolk, Va. He met death in the Civil War, and Sophia, accompanied by a group of faithful slaves, moved to Waco, Tex., where she was soon married to Judge James Porter of Missouri, a Confederate leader. They returned to Glen Eden, which again became the center of social activities. Judge Porter died in 1886, but Mrs. Porter lived until 1897. In the restored home will be placed much of the furniture, china, and silver that once belonged to its mistress.

The discovery of oil in April, 1940, near Cumberland, Okla., within the reservoir area, entailed work that had not been foreseen when the dam was projected and that cost $5,000,000. The field belongs to the Pure Oil Company and extends for 4½ miles in Bryan, Johnston, and Marshall counties. It now ranks second in production among the fields in Oklahoma, and according to estimates will ultimately yield 140,000,000 barrels of petroleum. To protect it from inundation, three dikes, totaling 23,500 feet in length, and two channels with an aggregate length of 9000 feet were built under contract by the W. C. Shepherd Company of Atlanta, Ga. The dikes will keep the water out of the area, while one of the channels will divert the Washita River a mile eastward. This work was started last April and has just been completed. It involved the removal of 8,000,000 cubic yards of earth of which 4,800,000 cubic yards was used for fill.

Although the clearing of the reservoir area began in 1939, actual construction was not undertaken until the spring of 1940, when George W. Condon Company and John Kerns Construction Company began excavating at the site of the outlet works, which were built by C. F. Lytle Company of Sioux City, Iowa. This was the first of three contracts executed by that concern, which also did the spillway concrete work and constructed the powerhouse.

The outlet structure proper rises in the reservoir area just upstream from the dam. It is 255 feet wide, 60 feet thick, and 150 feet high, and is connected with what was the Texas bank of the river channel by an access bridge 300 feet long. Under normal operating conditions it will project 40 feet above water level. Its purpose is to control the flow of water through the conduits, and this will be done by means of gates of which there are two for each conduit, or a total of sixteen. They will be under



CROSS SECTION

Drawing shows relative disposition of the three classes of material that were rolled into the embankment. The thickness of the structure at the base varies at different points, ranging up to a maximum of 2000 feet. At the left are details of the upstream-slope protection.

COMPACTING THE FILL

At the left, a truck is delivering a load of material from a borrow pit. Beyond it are a scarifier and a bulldozer distributing and mixing a layer of earth. At the right-center are three sheep's-foot rollers compacting material that has been spread, sprinkled, and scarified. At the far right is one of the 4500-gallon sprinkler trucks. At the upper right is the intake structure of the outlet works. The conduits pass under the dam, the flow being from right to left. The picture was taken with the camera facing south toward the spillway section of the dam.

100 feet of water when the reservoir level is normal and will be opened and closed from the operating deck of the outlet structure. The gates that will ordinarily be used are operated by individual 120-ton motor hoists. Upstream from these gates are emergency gates, the closing of which will make it possible to work on the regular gates. They are all raised and lowered by a 120-ton Whiting gantry crane that runs on rails on the deck. Ahead of the emergency gates and over the entrance to the power conduits are trash racks. An elevator and a stairway lead from the operating deck to the conduit level and connect at the bottom with a service passageway that provides access to the powerhouse ust downstream from the embankment. Leading to the intake of the conduits is a concrete approach channel 245 feet wide and 200 feet long. At the downstream end of the three flood-control conduits is a stilling basin 170 feet wide and 526 feet long.

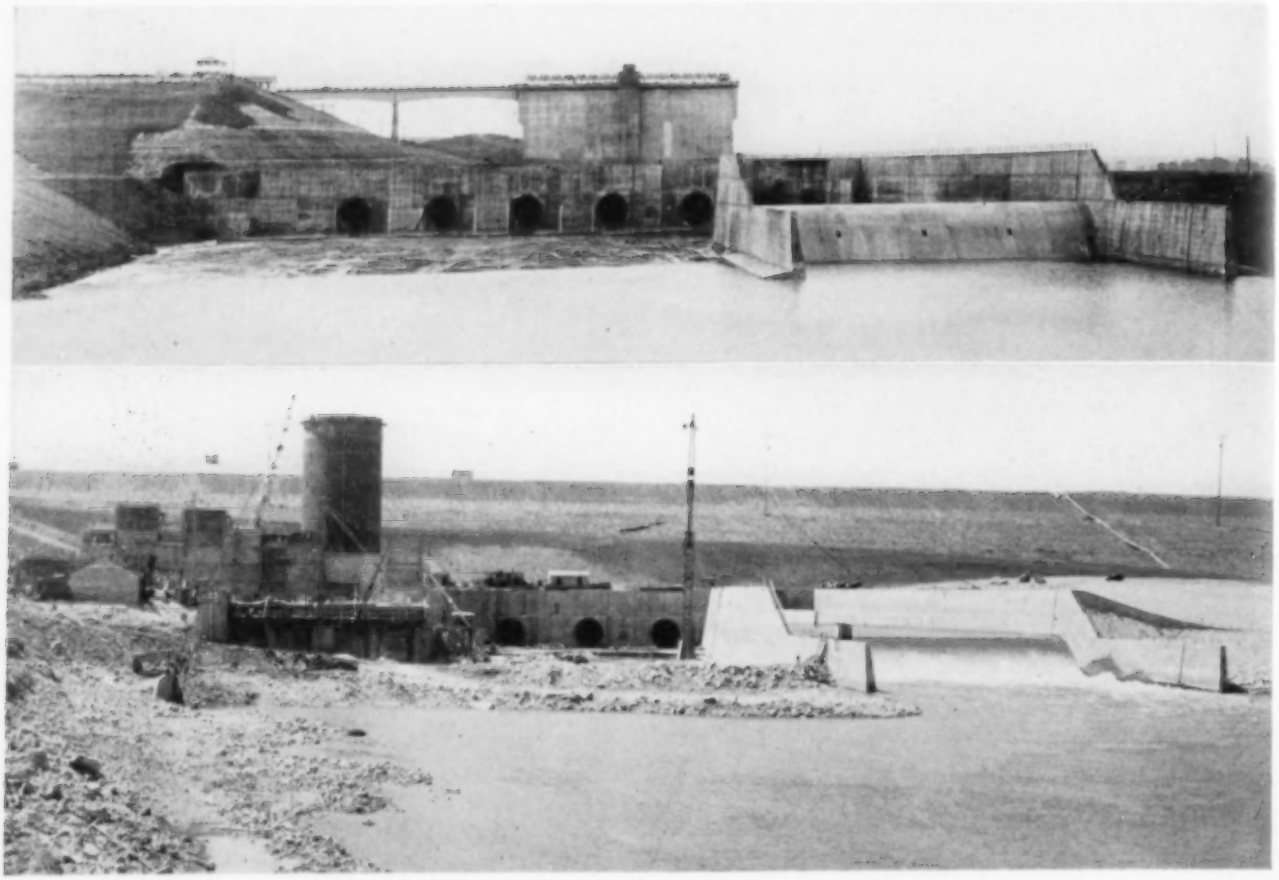
All these structures were put in place by the Lytle Company before the dam was reared, and the work called for the placing of 236,000 cubic yards of concrete throughout an area measuring 256x 1632 feet that was served by a traveling cableway having a span of 1660 feet. Buckets of concrete were delivered by shuttle trains running on a trestle extending from a central mixing plant on the Texas bank to the cableway. The mixing plant received aggregates over a belt conveyor system from stockpiles located high on the side of the valley.

The conduit section contains 150,000 cubic yards of concrete in a block 800 feet long, 256 feet wide, and 28 feet high. The three conduits or sluceways for flood control were left unlined, but the five power penstocks were lined with ½-inch steel plate reinforced with 10-inch-wide flange beams on approximately 3½-foot centers. These liners arrived in the form of arc segments which were put together in the field. Three segments made a ring 10 feet 5 inches long and weighing 11 tons. Assembled sections were moved into position by cableway. The contractor's operations were aided by the use of numerous pneumatic tools. Compressed air was furnished by four machines with a combined capacity of 2650 cfm.

The dam embankment was built by Guy F. Atkinson Company of Oakland, Calif., which received the contract in April, 1940, and moved the first earth the following August. In cross section, the embankment is made up of pervious, random-pervious, and impervious materials. The pervious material is essentially pure sand and was placed in the downstream portion up to within 90 feet of the top of the structure, a total of 4,072,000 cubic yards being used. Random-pervious material contains some clay, and 5,000,000 cubic yards of it was required. The impervious material has a higher clay content and was used to the extent of 7,200,000 cubic yards. An upstream blanket and downstream berms involved the placing of an additional 2,000,000,000 cubic yards of earth. To promote sodding, 113,000 cubic yards of topsoil was spread over an area of 3,000,000 square yards, principally on the downstream side of the dam. The foregoing quantities refer to the materials after their compaction in the dam and total 18,385,000 cubic yards, as given in the opening paragraph. Prior to compaction, they aggregated 19,700,000 cubic yards. Besides, more than 90,000 cubic yards of coarse sand and gravel and 204,000 cubic yards of limestone spalls and riprap were placed on the upstream face to prevent damage by wave action.

All the pervious and impervious materials were obtained from borrow pits in the vicinity of the dam site. In order to get a uniform mixture from the stratified deposits, a cut was taken the full height of the face—in some instances 15 to 18 feet in extent. Three 6-yard electric and two diesel shovels with a capacity of 2½-3 yards worked in the pits, loading into forty 20-yard and twenty-eight 13-yard trucks. The average round-trip haul was 3-3½ miles, the maximum was 5½ miles, and the total truck travel was well over 1,000,000 miles.

The earth was dumped, spread with bulldozers and graders, and then moistened and rolled. Pervious material was rolled in 1-foot layers and impervious and random-pervious in 6-inch layers. Four sprinkler trucks, each of 4500-gallons capacity, did the moistening, the water being obtained from four wells. The earth was compacted with double, articulated sheep's-foot rollers connected



POWERHOUSE AREA

The top picture, taken looking upstream toward the outlet works, shows the stilling basin and the downstream end of the conduits. The high structure is the intake for the conduits and is 800 feet beyond their discharge ends. Since this view was taken in October of 1941 the dam has been built up in the intervening space. At the bottom is a picture taken from approximately the same spot in September, 1943, of the powerhouse under construction and, beyond it, of the substantially completed dam. The latter obscures the intake structure

in parallel and drawn by 100-hp. Caterpillar tractors. The roller feet exerted a pressure of 550 pounds per square inch, and a complete outfit weighed 64,000 pounds. Six passes were made over each layer of pervious material and seven over random-pervious and impervious. Government engineers not only continually checked the materials before they went into the dam but also took regular samples from the dam itself by means of a truck-mounted, hydraulic drilling rig that extracted cores during and after rolling.

Extending longitudinally throughout the greater part of the dam foundation is a curtain of steel sheet piling to check seepage. This was driven on a line approximately 100 feet upstream from the center line of the structure. Where the earth overlying the rock foundation was too thin to permit seating the piling, a cut-off trench was excavated to the rock and then backfilled with pervious material.

Because of the immense amount of power equipment required, the contractor maintained shops for servicing it, the facilities extending even to equipment for retreading pneumatic tires. The 20-yard trucks used for hauling fill were shop assembled. Sixteen smaller trucks were utilized for moving sand and gravel, and there were three small shovels on the job for miscellaneous excavating. A total of 32 tractor-bulldozers was in service. Work was conducted in two 10-hour shifts. On many days more than 55,000 cubic yards of fill was placed, while the daily average was around 35,000 cubic yards.

During the first two years of the work the river ran in its regular channel, the embankment being carried to within a short distance of it. Then it was diverted through the conduits by constructing, upstream, a cofferdam that was later rolled into the upstream blanket. Another cofferdam was erected downstream to prevent the water from backing into the old riverbed area. The closure of the upstream cofferdam was effected on July 27, 1942. This made it possible to continue the embankment across the gap. A part of the old riverbed, however, was found unsuitable as a foundation and it was necessary in places to remove material as much as 40 feet deep. A well-point system was installed to lower the ground water in order to excavate and backfill this area. Some 1300 well points with perforated bottoms were sunk to depths of 20 feet. Through these the ground water was pumped into a network of 16- and 20-inch pipes at the surface and discharged into the river, downstream. The river portion of the dam was then rolled into place, and thereafter the embankment was built up progressively throughout its entire length.

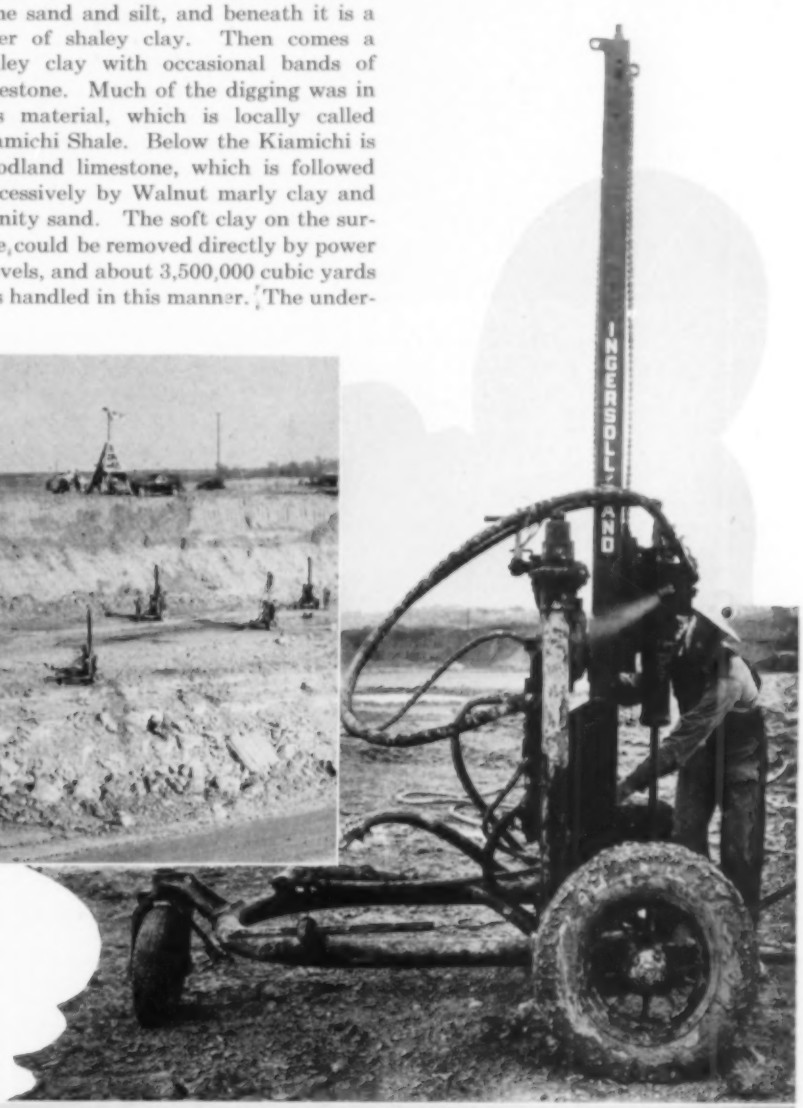
Progress was impeded at various times by high water. On seven occasions the contractor's service bridge across the stream was washed out. In the summer of 1942, only a short time before the closing of the river section, the flow reached a volume of 183,000 second-feet. To help out in that emergency, the 86th Engineer Battalion of the regular Army —350 enlisted men and ten officers— moved into the area from Camp Robinson and constructed a 486-foot ponton bridge that permitted the resumption of haulage across the waterway. The bridge was supported on 48 aluminum flat-bottomed hulls, each 36 feet long, 6 feet wide, and 4 feet deep.

In addition to building the dam, Guy F. Atkinson Company did the excavat-

ing for the spillway. As that structure occupies high ground on the Texas side of the valley, it was necessary to cut down the hillside to some extent to provide an approach. The biggest job, however, was on the downstream side, where there is a chute whose converging sides lead into an outlet channel 400 feet wide and 2400 feet long. In the latter area the excavation was carried down a maximum of 142 feet, and a huge chasm was scooped out of the earth. All told, 11,000,000 cubic yards of material was removed. The chute decreases in width from 2000 feet at the crest to 1600 feet at the bottom and is 460 feet long. The upper 235 feet is built on a slope of 1 to 10 and the lower part on a slope of 1 to 2½. As this section was to be paved, care had to be taken during the final excavating so as not to shatter the surface. Two feet of protective material was left in place for removal just prior to paving. When the spillway is overtopped, the water will flow over the 2000-foot-long weir, down the chute into the pilot channel, and thence into the valley of a creek that will lead it back into the river below the dam.

About 7,500,000 cubic yards of the spillway excavation had to be drilled and shot. The surface is brown clay with some sand and silt, and beneath it is a layer of shaley clay. Then comes a shaley clay with occasional bands of limestone. Much of the digging was in this material, which is locally called Kiamichi Shale. Below the Kiamichi is Goodland limestone, which is followed successively by Walnut marly clay and Trinity sand. The soft clay on the surface could be removed directly by power shovels, and about 3,500,000 cubic yards was handled in this manner. The underlying Duck Creek and Kiamichi shales required drilling. The excavation for the stilling basin was carried down to the top of the Goodland limestone, which withstands weathering and erosion well.

Drilling was done with five Ingersoll-Rand FM-2 wagon drills powered with air that was partly supplied by three K-500 Mobilair compressors. Jackbits



SPILLWAY EXCAVATION

The excavation for the spillway weir covered a stretch a mile long upstream and downstream, but the greater percentage of the 11,000,000 cubic yards removed was taken from the downstream area in which these pictures were taken. At certain horizons material hard enough to require drilling and shooting was encountered. Five wagon drills and two portable compressors that supplied them with air are shown at work at the top. A close view of one of the X-71 drills used in seen at the right. The nature of the material made it difficult to clear the hole of cuttings. This problem was solved by employing Jackbits with sidehole openings and by alternately blowing water and air through the drill and down the hollow drill steel. The water was used while drilling was in progress and the air was applied to force the gummy mud out. The latter rose in the form of a cylinder around the drill steel and was cut off at the surface with a shovel. A section of the huge cut that was made for the pilot channel is shown at the bottom with the spillway weir at the top-right and the sloping downstream chute below it.

CUMBERLAND OIL-FIELD WORK

This picture shows operations in progress on the cutting of a channel by which to divert the Washita River a mile eastward. This is part of a $5,000,000 program to prevent the inundation of a new oil field that was brought in after work on Denison Dam had been started.

with side holes were used to minimize plugging, and water pressure was maintained to keep them clear and to remove cuttings from the drill holes. The pattern of the drilling varied according to the nature of the formation and the size of the shovels available from time to time to handle the broken material. The maximum depth of hole was 20 feet. Blasting was done with Atlas gelatine dynamite, mostly of 40 percent strength.

The concrete work on the spillway was done by C. F. Lytle Company, and included the weir, a 75-foot section upstream from it, the downstream chute, and necessary side-wall structures. A total of 185,000 cubic yards of concrete was placed. The chute was laid in 30-foot transverse strips with mastic joints. After removing the 2 feet of material left on top of this section by the Atkinson Company, a trench 4 feet deep was cut along the line representing the upper edge of each 30-foot strip. These trenches serve as keyways to hold the pavement securely in position. In the bottom of each trench were drilled holes on 4-foot centers and to a depth of 10 feet into the underlying rock. These holes were put down with five Ingersoll-Rand Type FM-2 wagon drills using 4-inch Jackbits. A 1¼-inch square steel bar was concreted in each hole and the trench filled with concrete to the level of the base of the slabs that were to be laid later. These bars had a reverse bend at their upper ends and were cut into lengths so as to extend upward a predetermined distance into the top layer of concrete.

To serve as a base for the slabs there was placed 6 inches of sand followed by 6 inches of crushed stone topped by 6 inches of porous concrete—that is, concrete containing no fine aggregate. In the area of the 2 to 2½ slope, more anchor-bar holes were drilled normal to the slope through this porous concrete and 10 feet into the ground. These were ordinarily on 30-foot centers, but the pattern was not uniform. In all, 6800 anchor-bar holes were drilled. Air was furnished by two HK-500 Mobilair compressors and one XCB stationary machine of 1100-cfm. capacity. In addition to wagon drills, the contractor employed clay diggers and paving breakers of varying sizes for trimming the trenches and other excavations. The concrete pavement was laid 2 feet thick and was reinforced with a mat of ¼-inch bars embedded 6 inches below the surface. An area of 162,000 square yards was covered—the equivalent of 14-odd miles of 20-foot highway paved 8 inches thick.

The concrete for all the spillway work came from a central plant containing two 2-yard mixers. The cement was delivered in railroad cars and blown by compressed air through pipes extending from a siding to a storage silo. Coarse aggregates were obtained from the Southwest Stone Company at Stringtown, Okla., about 40 miles away, the source also of the riprap, spalls, and coarse aggregates used elsewhere on the job. Sand came from a pit on the Oklahoma side of the river. Most of the concrete was dumped into buckets resting on trucks, transported to pouring locations, and then handled by crane. In some cases it was hauled in truck bodies to points of application and there transferred to buckets. After the spillway chute was paved, it was covered with 18 inches of earth and 6 inches of topsoil. This is designed to protect the underlying concrete from weathering. Available flood records indicate that the spillway will probably not be required oftener than once every 100 years.

Work on the powerhouse, which was also built by C. F. Lytle Company, was started in November, 1942, and is now substantially completed. The site is on the Texas side of the river, and 50,000 cubic yards of material had to be excavated. A cableway was used in its construction, which called for the placing of 53,000 cubic yards of concrete. The generator room is 210 feet long, 60

POWERHOUSE FROM EMBANKMENT

This picture, which was taken on February 9, 1944, shows the exterior of the structure substantially completed. The surge tank rises in the foreground. At its left is the stilling basin at the downstream end of the conduits that will carry the normal outflow of water not needed for power generation.

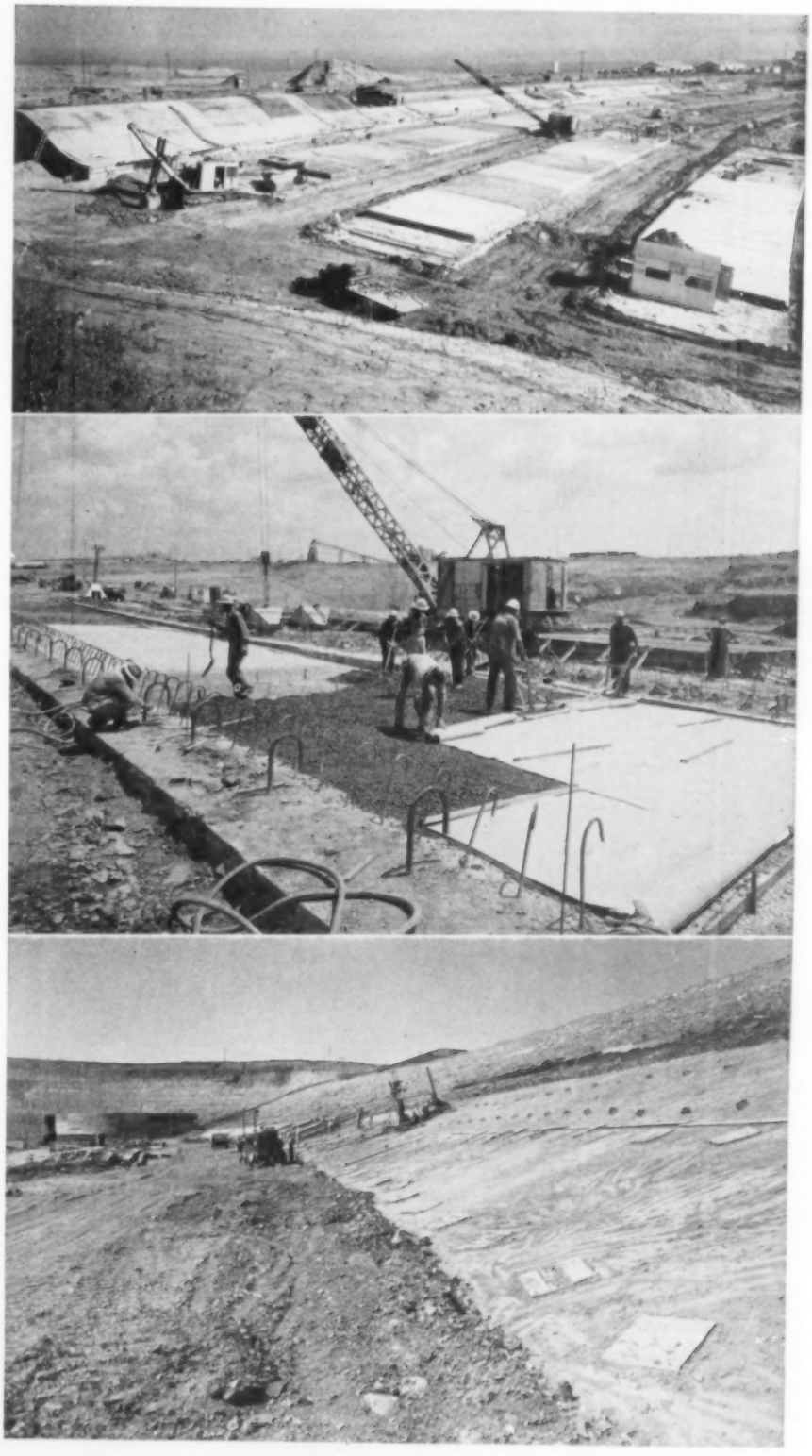
feet wide, and 55 feet high, and has in it an overhead traveling crane of 225 tons capacity which was needed to install the generating equipment. The unit now in place consists of a Westinghouse 35,000-kw. generator driven by an S. Morgan Smith 51,700-hp. turbine. The steel turbine runner is 16 feet in diameter and was cast in one piece. In shipping it from York, Pa., where it was made, the superstructures of two bridges had to be raised to gain clearance. The center line of the turbine is at Elevation 515. As the crest of the spillway weir is at Elevation 640, the maximum operating head will be 125 feet, but the normal operating head will be considerably less.

In connection with the powerhouse construction, it was necessary to anchor the concrete tailrace to the underlying Trinity sandstone. This entailed the drilling of 108 holes 6 inches in diameter and 20 feet deep. As there was not enough of this work to warrant bringing in a large-hole drilling rig, the contractor met the situation by ingeniously adapting equipment on hand for that purpose. Four-inch Jackbits that served elsewhere on the job were heated and flared to 6-inch size and the holes were put down with Type FM-2 wagon drills.

Denison Dam will be operated by the Corps of Engineers, U. S. Army, and the sale of the power produced will be handled by the Southwest Power Administration, which has charge of the distribution of electric energy from the Grand River Dam in Oklahoma and the Norfolk Dam in Arkansas. Lee Simmons of Sherman, Tex., was named local manager of the Authority last September, and Douglas Wright is administrator. The building of 15 miles of 138,000-volt transmission line from the dam to the Texas Power & Light Company's substation near Sherman, Tex., was authorized last November.

Plans to take advantage of the recreational possibilities of the dam after the war is over are being drawn up by the National Park Service and will be submitted to Congress. If they are approved, it is proposed to erect boat landings and to establish picnic grounds, park spaces, home sites, and otherwise to develop suitable locations along the reservoir shore.

The project was designed and constructed under the supervision of the Denison District, Corps of Engineers, U. S. Army. The building of the dam embankment and the excavating for the spillway was directed for Guy F. Atkinson Company by A. E. Holt, vice-president, who was assisted by F. R. Bonner. A. H. Steiner served as superintendent. The C. F. Lytle Company work was in general charge of F. W. Parrott, vice-president, and F. K. Lytle spent considerable time on the job. A. F. Mathis was project manager, and W. H. DeButts was chief engineer.



PAVING THE SPILLWAY CHUTE

The sloping chute just downstream from the spillway weir was paved by pouring concrete in alternating strips, as illustrated at the top. Before this was done, trenches were excavated along the lines where the upper edges of the strips would come, and these were filled with concrete to serve as anchoring keyways. First, however, anchor bars were concreted in holes drilled 10 feet into the rock at the bottom of each trench and allowed to project upward so that they would be embedded in the concrete. One of these keyways with projecting anchor bars is shown in the center. The men in the picture are compacting porous concrete, which forms the immediate base for the 2-foot final course of regular concrete. After the porous concrete had been poured, additional holes were drilled through it and more anchor bars concreted in place. At the bottom are seen two wagon drills putting down some of these holes.

This is an Engineer's War

Maj. Gen. Eugene Reybold

Signal Corps Photos

ON THE battlefront, military engineering is doing its part to end this global war. On the home-front, the all-day, all-out efforts of American engineering, production, and labor will do much to hasten the day when our soldiers shall return home—when the sweat of American labor will turn the bulldozers and cranes and shovels to the work of peace. But it is still a long road to Tokyo, and our inching toward Rome is warning of a hard road to Berlin.

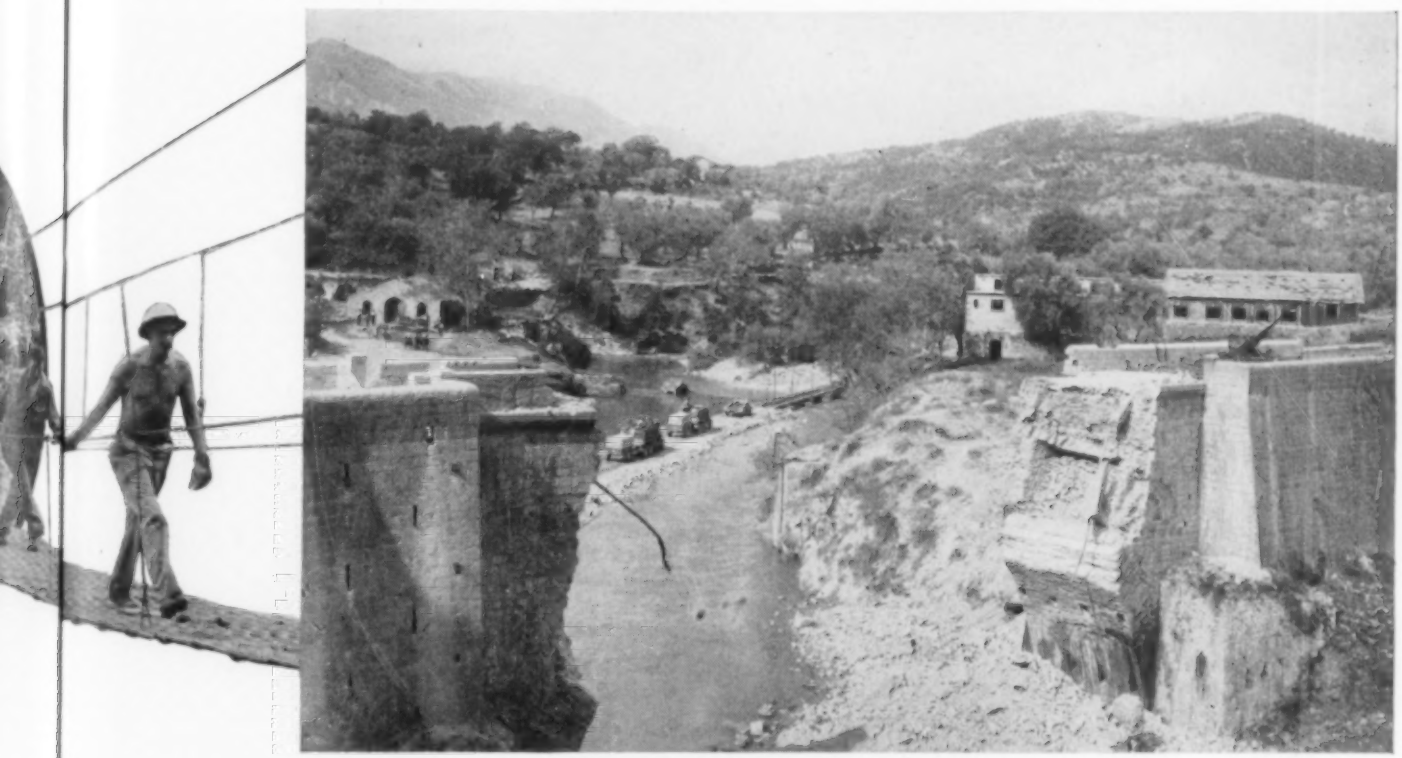
To win the war we must bring fire power against the enemy by air, land, and sea. And through it all, our sick and wounded must be cared for and a steady flow of matériel must be maintained. This means that bases, staging areas, and communications must be continually advanced toward the enemy. Otherwise fire power cannot be brought to bear, nor will supplies reach our ever-advancing front-line forces. As in all wars, the engineer clears the way. But, more than ever, this is an engineer's war.

There is considerable contrast between the two methods by which the present war is being waged. The first, illustrated on the Russian front, consists of the mass movements of land armies in the classical tradition. There we find it a simple matter to follow the strategy, as well as the objectives and the mode of their accomplishment. The high commands on both sides plan seizures of rail or road junctions, just as they were planned and executed in the American Civil War, the Franco-Prussian War, and World War I.

The other method, best illustrated by the Pacific campaigns, is different—both the strategy and tactics are unique. This new kind of warfare imposes an ever-increasing burden upon the engineer. It

MAJ. GEN. EUGENE REYBOLD
Chief of Engineers, U.S. Army, and author of the accompanying article.

Essential substance of an address before the Philadelphia Chapter of Military Engineers



AROUND THE WORLD WITH U.S. ARMY ENGINEERS

Above is shown a temporary bridge that was thrown across a river in Italy to replace the masonry span in the foreground that was demolished by the Germans. Note the antiaircraft gun on the damaged structure. At the extreme left is a bulldozer clearing a path through virgin timber in the construction of the Alcan Highway. A foot bridge built across a stream in New Guinea is pictured in the circle. Below it is an Ingersoll-Rand portable air compressor that was a part of the light equipment used in constructing an airfield in North Africa.

calls upon our greatest resources: our peacetime use of heavy earth-moving equipment, roadbuilding skill, and knowledge of soil conditions, in addition to new applications of old tactics on the battle line.* Essentially, it consists of amphibious and air "island-hopping." It entails, so far as the engineer is concerned, the construction of bases in preparation for attacks, engineering operations in actual combat calling for vastly multiplied missions, and the normal functions of repairing and rehabilitating captured territory.

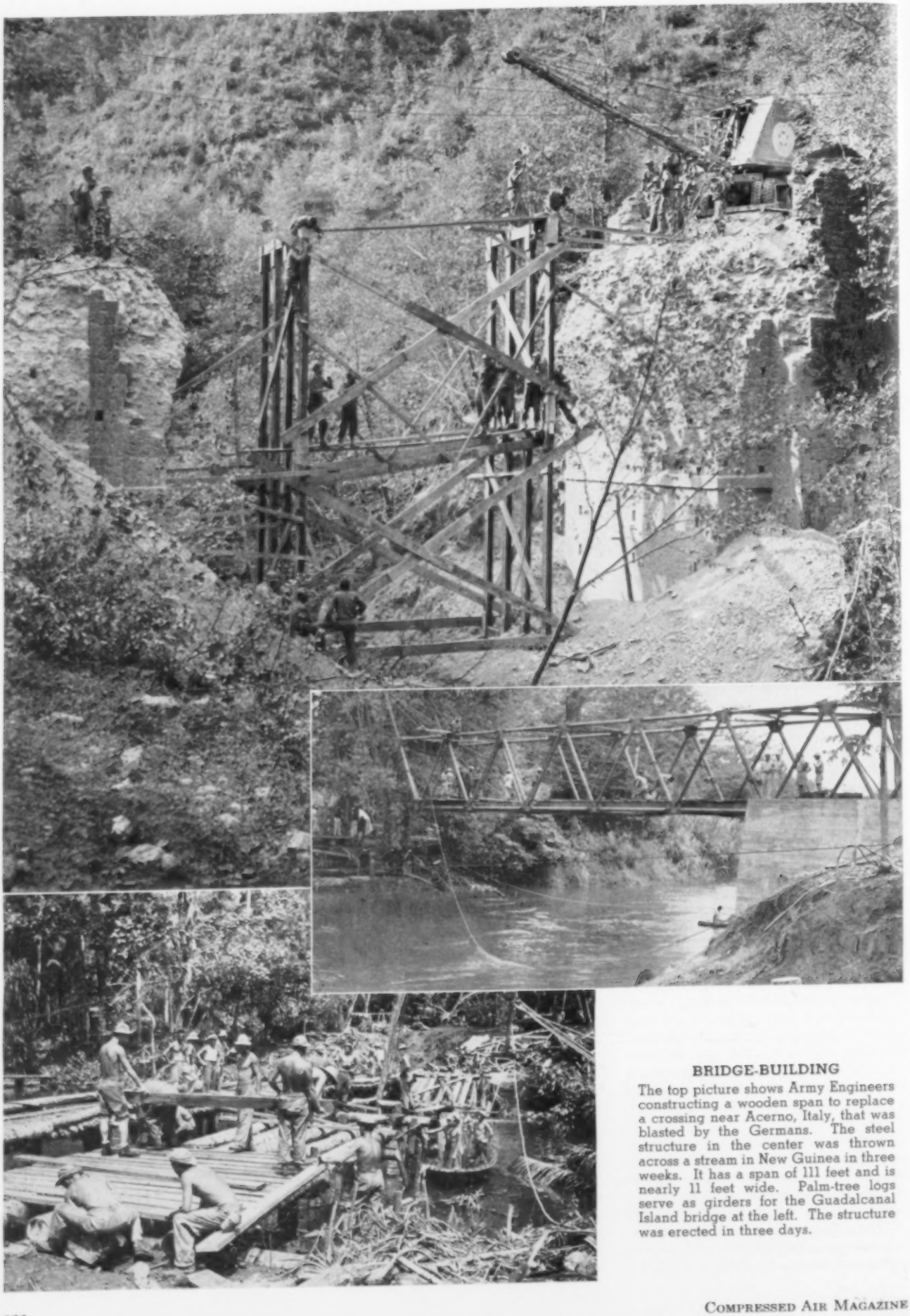
We can further classify this kind of warfare by contrasting the North African and Italian campaigns with those in the Pacific. In the former, the territory attacked amphibiously, or from the air, or both, is inhabited territory where transportation and utilities have long existed. In nearly all the Pacific area, however, no civilization, as we have known it in prior wars, has ever existed. The one calls for rehabilitation, the other for construction from scratch. As a matter of fact, some of the island battlefields in the Pacific are inherently such "bad land" that they were only sparsely occupied by natives before Japan employed them as outer-rim defenses.

I have visited the scenes of some of our military operations in the central, south, and southwest Pacific. What I saw there of past and current events best illustrates the tremendous engineering task which is our lot in those theaters. Out there we find nothing within miles but jungles and Japs. We secure a beachhead, and there's nowhere in God's world to go. We've got to punch through jungle, hunt a place for an airfield, and build it. Then we must construct landing docks and access roads. No utilities are waiting. The demand for work in such regions is far in excess of anything dreamed of before.

But let us first take a bird's-eye view of what had to be accomplished in rear areas to set the stage for tightening the noose around Tojo's Tokyo. In the north, from the bottom of Alaska out to the Aleutians, U. S. Army Engineers spent three years building air bases and other installations against the Japanese threat. In further defensive-offensive support, and to service the air link with our Russian ally, we hacked the Alaska Highway through literally unknown forests and mountains and over 200 major streams to insure a supply line. That line has paid dividends in the operation of the air route to Russia via Alaska.

After the Pearl Harbor catastrophe, installations had to be repaired and new ones feverishly constructed. It became necessary to pioneer an air route from Hawaii to Australia in order to support and supply our land and sea and air forces, which fought gallant defensive actions down to the southern rim and the eastern tip of New Guinea. Heavy bombers were using most of that route within one month after Pearl Harbor. Advance installations were necessarily built to and at Midway from which the successful defensive Battle of Midway was fought. In the south Pacific, following our peaceful occupation of the Ellice Islands, we advanced at no little cost in sweat and blood from speedily constructed Australian and New Caledonian bases to secure heavily contested footholds in the Solomons and in the Gilbert Islands. From these and other bases we are attacking and softening up the Japanese-mandated islands—the Marshalls and even the Carolines.

In the southwest Pacific it was the Engineers of a general service regiment who defended Milne Bay against the farthest-attempted advance of the Japanese. From Port Moresby it was the Engineers, in coöperation with the Air Force, who destroyed the mule-transportation system of the Japs over the Owen Stanley Mountains; and it was the Engineers who hacked out the advance air strips in the middle of impenetrable jungle from which our Engineer-Air Force team launched the drive back toward Rabaul en route to Tokyo. Our latest exploits are intimately connected with the conquests of



BRIDGE-BUILDING

The top picture shows Army Engineers constructing a wooden span to replace a crossing near Acerno, Italy, that was blasted by the Germans. The steel structure in the center was thrown across a stream in New Guinea in three weeks. It has a span of 111 feet and is nearly 11 feet wide. Palm-tree logs serve as girders for the Guadalcanal Island bridge at the left. The structure was erected in three days.

Finschhafen, the landings at Arawe and Cape Gloucester on New Britain, and at Saider on the northern New Guinea coast. By cutting the barge supply line, these latest operations have separated the Japanese forces still on New Guinea and those in the Netherlands Indies to the west of Rabaul.

In the China-Burma-India theater, now commanded by Admiral Lord Louis Mountbatten, the establishment of communications with Chiang Kai-Chek's gallant Chinese has been an engineering problem of gigantic magnitude under the most adverse conditions imaginable. Last October was made the first public announcement of the Engineers' Ledo Road project across 200 miles of northern Burma. Most of the press dispatches overlooked the fact that the highway traverses approximately the same wild area over which General Stilwell escaped from Burma in May, 1942. The contrast between Stilwell's retreat and the steady rumble of the Engineers' big bulldozers carving a way back, speaks volumes for the future operations in the China-Burma-India theater.

IRON WORK HORSES

Tractors serve the fighting forces in many ways, even going into combat in the South Pacific. This view shows American engineers using them to cut out the side of a hill in building the new Ledo Road that extends across northern Burma for a distance of 200 miles.

Our ability to move ahead in the Pacific has depended well-nigh entirely upon our ability to build bases for our aircraft. An airplane is a highly mobile unit, but it is landbound without an airfield. To expedite their construction, we have outfitted special Airborne Engineer units with miniature rollers and bulldozers that can be carried in transport planes. In the Markham Valley on New Guinea, just 40 miles from Lae, our reconnaissance planes spotted an airdrome site—several acres of flat grassland near the native village of Tsili-Tsili. The Engineer of the Fifth Air Force directed a hundred or more natives in the hand labor of clearing and grubbing runways, and on July 10 the first company of Airborne Engineers was flown in with its equipment. Sixteen days later the first fighter planes were using the strip, and as many as 150 transports were bringing in additional supplies and personnel each day. With this base as a staging field for both fighters and bombers, the Jap air strength at Wewak was effectively neutralized during the amphibious landings which captured Lae.

A short while later, at Finschhafen, U. S. Army Engineers again proved the value of their equipment and doctrines. Although the Japanese had held the latter for a year and a half, their lack of heavy machinery kept them from developing more than a single puny landing strip. Without air opposition, we seized the position in October. The Nipponese soldiers, retreating up the mountainside, had box seats at a demonstration of how our Engineers do big things in a big way. Exactly one week after we had brought our construction equipment ashore, our bulldozers and dynamite had cleared a heavily timbered stretch of jungle. In three weeks our troops were laying down a landing mat on a coral runway more than a mile long. Seventy thousand cubic yards of soil had been moved from that runway and replaced with coral dug from the drainage ditches. The pay-off on that engineering job is that we are now on New Britain.

Guadalcanal and Munda are firm American toeholds in the south Pacific. Air activity is amazing at both places. Every few minutes planes are either taking off or coming down, going on an attack or a patrol mission, or returning from one. Pilots, asleep near their planes, can be in the air in four minutes in case of an alert. But none of this would be possible without the work of the Engineers. Once an airfield is built, it is necessary to build roads leading to it. Highways, teeming with military traffic, now honeycomb many tropical islands which were just dense jungles a few months ago. In New Guinea, alone, around one occupied area, hundreds of miles of military roads have been constructed since it was captured by allied forces in the spring of 1943. Trucks and jeeps, carrying all kinds of equipment, have kept this netowrk plenty busy.

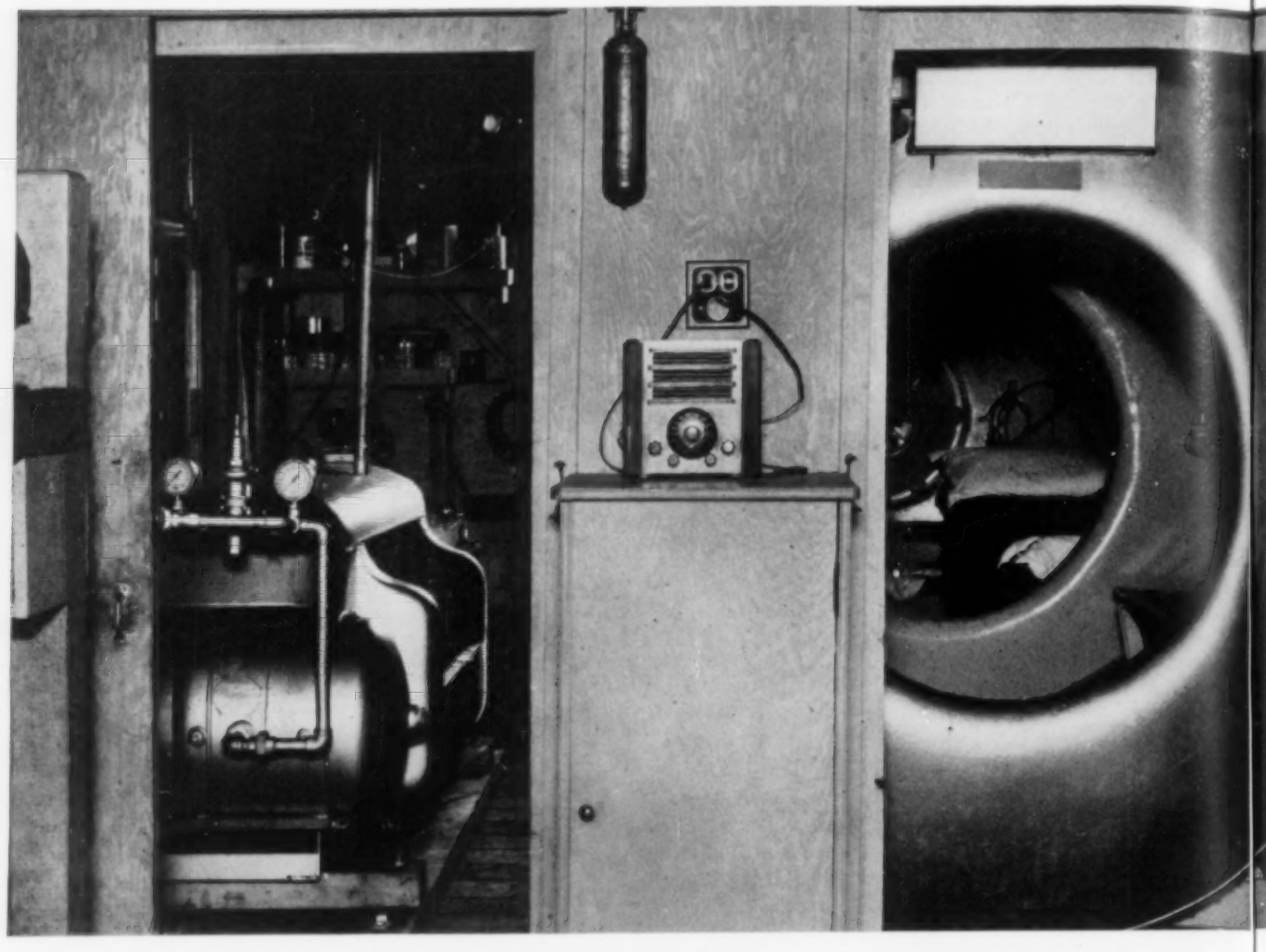
It should not be forgotten that the Engineers also play a part in actual combat—in driving the enemy from his strongholds. Around Oro Bay, in New Guinea, the Japanese had burrowed so deep into the ground that it was difficult to get them out. Finally our troops resorted to bulldozers. They lifted the blades so that they would serve as shields against rifle bullets, ran the big machines up close to the holes, and tossed in grenades. In landing operations to secure new beachheads our bulldozers have knocked ramps through embankments that would otherwise have stopped our trucks and tanks. We have used them as "points" for infantry columns moving through the jungle. Their operators have been targets for so many snipers in areas supposedly cleared of Japanese that they have been protected by armor, so that the machines may now be classified as combat weapons.

While our Pacific operations involve all the difficulties of amphibious and air landings and construction, they do not often entail mass troop action and complete occupation of every square foot of territory thus brought under one control. The fighting itself is not unlike the Indian warfare of the days of Rogers' Rangers. Our tactics, so far as the outer rim of Japan's defenses is concerned, is to constrict the collective Jap throat—to shut off supplies. As we approach his inner bastions, particularly overland through the ancient civilization of China, much of that war will revert to classic form.

Slowly but surely, from base to base, we are driving back across the Pacific Archipelago. But the rate of our advance depends largely upon the speed with which we are able to build. The efficiency and rapidity with which U. S. Army Engineers are constructing military airfields, highways, and docks under the most difficult of conditions are examples of the magnificent job they are doing in faraway places.

Use of Compressed Air Increases in Marine

Robert G. Skerrett



SALVAGE-WORK COMPRESSORS

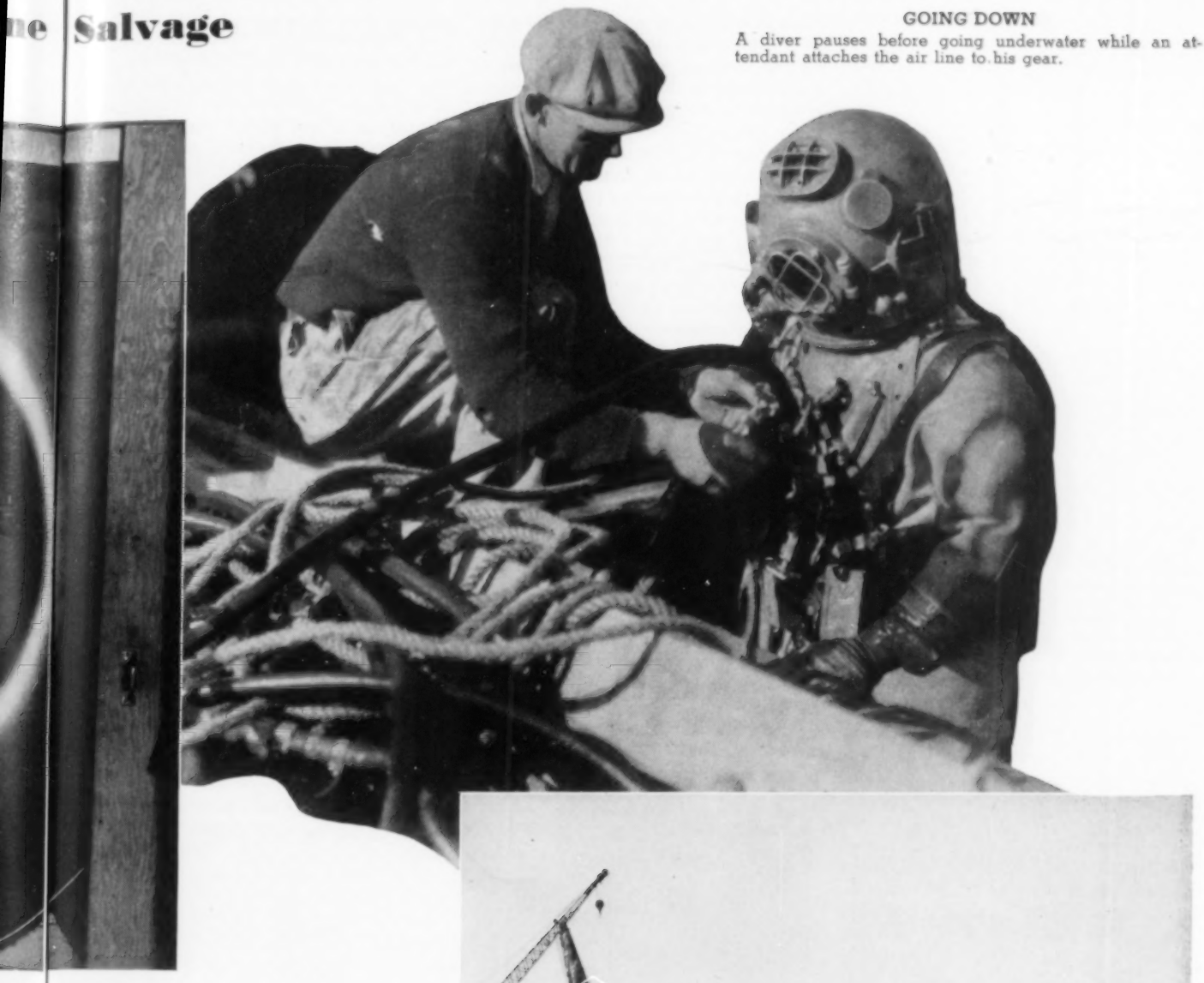
The picture above shows the interior of a decompression chamber such as is always provided on a salvage job for the treatment of divers who may become afflicted with "the bends." A small skid-mounted compressor (left) furnishes air for putting the chamber under pressure. The lower view on the opposite page was taken during the raising of the U.S.S. "Oklahoma" following the attack at Pearl Harbor. Mounted on the barge at the right are two Ingersoll-Rand K-500 portable compressors that supplied air for the operations.

THE U. S. Navy Salvage School at Pier 88, New York City, is, as explained in COMPRESSED AIR MAGAZINE for January of this year, an institution that has already established a reputation in meeting a current wartime need for submarine mechanics capable of dealing with ships damaged either by hostile attack or by stress of storm or fog. Although organized as a temporary measure, it has taught lessons of permanent value, and especially how compressed air and pneumatic tools can be used to a far wider extent than was heretofore believed practicable.

The vessels stricken at Pearl Harbor early in December of 1941 presented a salvage undertaking of stupendous proportions, and the reclamation of as many of them as possible with dispatch was an urgent matter. The task was one of dealing with ships that not only had settled to the bottom of the harbor but whose structures had been torn and twisted by the blasts of bombs and torpedoes charged with high explosives, supplemented by the seering flames incident to the ignition of tons and tons of fuel oil.

Compressed air in large volumes was made use of, just as marine wreckers have done for years, in either forcing water in flooded compartments down and out through Kingston valves fitted to the bottom plating or lowering it to the top line of a rent in the hull through which the water had entered. Some of the water could thus be expelled and the hole patched with plates prepared for the purpose or sealed with temporary timber bulkheads, much as "pudge boards" are employed in advancing the heading of a subaqueous tunnel under air pressure. The bulkhead was placed over the hole on the pressure side, and as the water was forced out and the level dropped, board after board was added from top to bottom until the gaping wound was closed. With the bulkhead firmly in position, the compartment was unwatered and the air pressure gradually reduced. Admission to a flooded space, dealt with in this manner, was through an air lock fitted to the cover of the hatchway leading to it.

Some of the flooded compartments, after closing the hull openings with other types of emergency patches, were unwatered by recourse to wrecking pumps or to air lifts devised on the spot



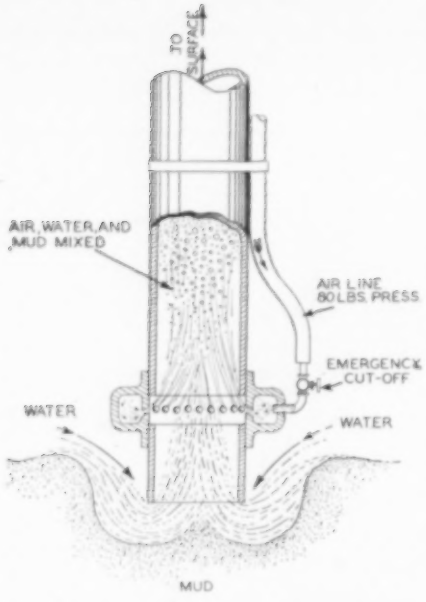
GOING DOWN
A diver pauses before going underwater while an attendant attaches the air line to his gear.

Press Association, Inc.

for the purpose. The piping for the latter ranged in diameter from 6 to 14 inches, but the 12-inch was generally found best suited for the work because the lifts occasionally had to handle sizable chunks of coral rock and lava rock, as well as gravel and sand. In addition to the air lifts, which performed well, air-operated siphons also were constructed and used successfully in tunneling under a wreck in soft or gravelly bottoms. They were effective in lifting rocks and other material that could pass through the piping, and proved to be especially serviceable in clearing cargo such as coal, broken stone, gravel, or sand, from a sunken craft.

Most of the ships at Pearl Harbor burned fuel oil, and in order to transfer it from the storage tanks to the boilers, or to shift it from one tank to another in maintaining a vessel's trim, the reciprocating pumps in the flooded compartments were driven by compressed air instead of steam during the period of submergence. The divers assigned to operating the pumps had to be thoroughly competent—to know where to find the connection to each tank and the proper venting valve so as to avoid subjecting the tank to excess internal or external pressure. The first step necessitated breaking the steam-supply line and connecting the compressed-air line. As a result of this substitution, it was possible to discharge oil above water for salvage, and the tanks so drained afforded helpful buoyancy.

Much of the air used in recovering the stricken ships at Pearl Harbor was supplied by portable compressors that, as luck would have it, were available. These machines also provided power for



AN AIR LIFT PUMPING MUD

The emergency hand-controlled valve enables a diver to shut off the air supply quickly if he becomes caught in the suction. He also uses it when the air-lift intake becomes clogged and he has to remove the obstructing material.

numerous other purposes such as sand-blasting rusty metal surfaces or those coated with accumulations of mud, barnacles, and other marine growths that develop rapidly in warm sea waters. Air was needed to operate Utility hoists, which were widely employed, and helped to save much equipment and material. Pneumatic tools of various types were required for a diversity of jobs, and had plenty to do. Such is the background of experience, gained under pressure, that led to the organizing of the U. S. Navy Salvage School as a temporary means of contributing to the force of divers that was needed for the righting and refloating of the *U. S. S. Lafayette*.

As a result of what has been learned at the school and what the graduates have acquired since then in the field, we have obtained a fund of practical information that puts a new light on the value of air-driven tools for service underwater—that emphasizes how much is to be gained by utilizing such tools. Their part in marine salvage has become a conspicuous one, and they are undeniably a means of shortening any subaqueous operation and of lessening the drain upon the strength of the diver.

In the past, where pneumatic tools were used for underwater work both in the Navy and in commercial salvage, the idea prevailed that the back pressure of the water against a tool's exhaust tended to make for unsatisfactory operation. The theory was that, except in decidedly shallow depths, manual work should take precedence over the air-driven tool unless steps were taken to neutralize the back pressure of the water by leading the tool's exhaust up to the surface through a connecting hose—a complication in that just one more piece is added to the equipment that a diver must always keep in mind.

It is therefore interesting to learn that the tools can be operated efficiently at any depth provided the pressure of the air is increased sufficiently to give the exhaust a discharge pressure that will exceed the hydrostatic pressure. For example, if a diver is at work 100 feet below the surface, and if his tool's normal operating pressure above the surface is between 80 and 90 pounds per square inch, then the air sent down to the tool should be around 144 pounds per square inch. The additional air pressure represents the absolute pressure at a depth of 100 feet and, plainly, is the pressure that must be overcome by the exhaust in order to neutralize the water pressure. Such is the practice in the Navy today in submarine salvage, and, when followed, the tools can be counted upon to give excellent service. In the case of tools of the Multi-Vane type, however, it is desirable to fit a nonreturn valve over the exhaust to prevent water from getting in and rusting the drive. This is a simple remedy, and the operation of the valve does not call for any special increase in working pressure.

Air-driven tools of well-nigh all kinds are now used underwater by the Navy's salvage divers and do about the same kind of work that is required of them in the open. Rock drills are employed to a considerable extent when a ship is caught on a reef or is "beached" or grounded and rocks have pierced the bottom, gripping the craft and making it difficult if not impossible to pull her free by a straight drag. In such an emergency they serve to put pop holes in the rocks so as to blast the obstruction and to free the vessel.

Navy practice is to blow lubricating oil down through the air-supply line to whatever pneumatic tool happens to be in use. At the Salvage School, a lubricator is installed in the line at a convenient point above water and is arranged in such a way that it is possible to regulate the air supply for the tool on that line. The oil provided for this purpose is Ingersoll-Rand No. 10. It is a light oil and has been developed especially for low-temperature work, such as submergence and the refrigerating action of the exhausted air involves. Should even that oil give signs of sticking, naval men familiar with diving operations say the trouble can be corrected by introducing a small amount of alcohol in the line.

All air tools that are required to work underwater, where they may be exposed to mud and sand in suspension, must be

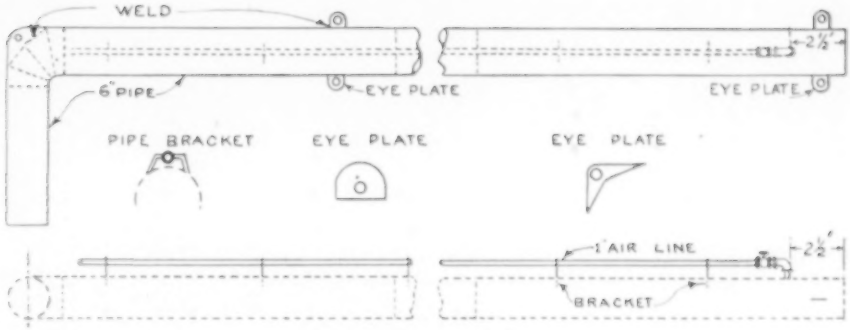
DRILLING SUBMERGED ROCK

This diver is drilling rock in shallow water in a European harbor. The exhaust from the drill is visible on the surface. Divers similarly use rock drills and other types of pneumatic tools in salvage work many feet underwater.

carefully cleaned when brought to the surface and before they are placed in reserve for reissue. However, the men are cautioned against bathing or dousing them in kerosene because kerosene is likely to cut the lubricating oil and invite trouble during the next submergence. The tool can be washed off and then cleaned thoroughly with oil provided for the purpose.

Details of a typical air lift, as devised at the school, are shown in an accompanying drawing and are applicable to a lift of any acceptable size. The air-supply hose is commonly of ¾- or 1-inch diameter and the air is delivered through an encircling double-walled casting the inner wall of which is perforated with numerous small holes to break up the air into strong streams of small bubbles. It is the prevalent opinion that this arrangement improves air-lift performance. At a point in the air line where an elbow turns into the casting there is a hand-controlled valve which enables the diver working with the lift to shut off the air quickly. This is a safety measure so that the diver, if caught in the suction of the lift, can release himself. It also makes it possible for him to withdraw anything that might temporarily plug the intake. The force developed by one of the largest of these lifts has at times been sufficient to raise pieces of rock big enough to jam the elbow at the surface end.

There are numerous situations, however, where the intake of a lift cannot reach a point to one side of the hatchway or deck opening in which it is installed. This can be overcome by attaching flexible tubing to the intake or, better still, by resorting to an air-operated siphon which, in principle, is another form of air lift. While 12-inch pipe is generally recommended also for the siphon, excellent results have been obtained with piping half that size. Large hose can be

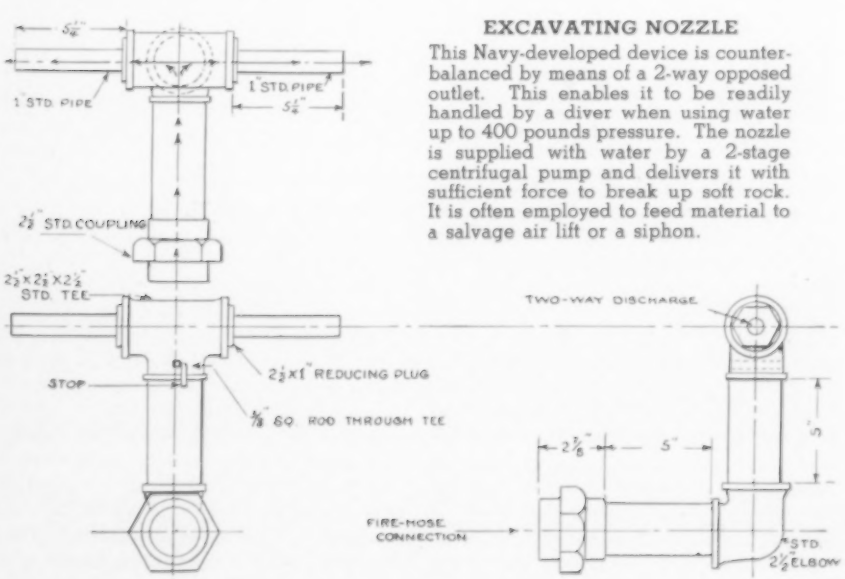


DETAILS OF SIPHON

The siphon is often used for underwater excavating in places that are not readily accessible to the larger and less adaptable regulation air lift. In tunneling under a ship, the siphon can be bent to fit around the hull. Experience has shown that a 12-inch pipe is best suited for general service, using a 1-inch air line with air at 100 pounds pressure. The siphon will lift rocks that are small enough to pass through it and can be utilized to remove cargo such as coal, gravel, sand, or grain from a sunken vessel.

used to extend a siphon for a considerable distance, and its flexibility enables a diver to shift the intake to any desirable location. The air discharge from the pressure line should enter the apparatus not less than 2 feet from the bottom. At the start of operations, compressed air must be fed gradually to reduce any "kicking" or forcible switching of the intake, and the diver should keep away from the siphon until it has settled down to steady work, which it will do quickly. The apparatus is capable of doing much useful excavating underwater, and for some purposes may be found handier than the larger and less adaptable air lift.

The Navy has developed a simple and satisfactory counter-balanced excavating nozzle for use with water delivered by high-pressure pumps through 2½-inch fire hose. It has been utilized and controlled with ease when the operating pressure was as high as 400 pounds per square inch. It would be impossible for a diver to handle an unbalanced nozzle at less than half that pressure without inviting serious exertion if not harm. The Navy's nozzle is a swivel-handle with a 2-way opposed outlet one of which the diver directs ahead while the other discharges rearward and past him. A stop welded to the nipple below the head tee prevents him from heedlessly unscrewing the tee when shifting the nozzle from point to point as occasion may require. Units of this description serve to move mud, gravel, and other materials to the intakes of stationary air lifts as well as of siphons, and when operating at pressures up to 400 pounds have been employed to break up soft rock such as coral found in many areas in the Pacific. On soft bottoms, lower pressures answer the purpose. Before a diver goes down to work with an excavating nozzle the water must be fed slowly to the supply line to force the air out of it and thus to quiet any tendency of the nozzle to kick.



EXCAVATING NOZZLE

This Navy-developed device is counterbalanced by means of a 2-way opposed outlet. This enables it to be readily handled by a diver when using water up to 400 pounds pressure. The nozzle is supplied with water by a 2-stage centrifugal pump and delivers it with sufficient force to break up soft rock. It is often employed to feed material to a salvage air lift or a siphon.

Paving breakers are very effective tools for underwater work and serve to shatter bottom formations of certain kinds, as well as to clear away concrete and other materials that may be inside a flooded ship. Anybody familar with air-operated tools and with the many-sided nature of marine-salvage problems will readily envision handy applications for them. The impact wrench has proved of great help in backing off nuts on bolts that hold down gun mounts and machinery foundations and in breaking other connections, thus permitting the equipment to be reclaimed for use elsewhere long before the wreck of which it formed a part could again be made fit for service.

With exception of the primary sources of compressed air and the pneumatic tools, the apparatus described has been largely improvised and successively developed by the U.S. Navy during the present war and indicates to some extent what may be expected in postwar marine salvage.

Pass the Ammunition

Carey Holbrook

KRAUSE AND HIS SHOP

The business that F.R. Krause started as a service for a few friends now takes his full time, but a converted garage is still its home. At the right he is shown with some of the many guns that are sent him from all parts of the country to be repaired.

COPPER, zinc, and lead, in common with other base metals, have gone to war, a fact that is well known to everyone who has tried to buy anything made of them. Sportsmen are especially cognizant of their absence from the usual trade channels because they can no longer drop into a store and buy cartridges for their guns. However, this doesn't mean that all the shooting has stopped on the home front. Most hunters have a small supply of ammunition that was laid by in days of plenty. Those who do not possess such a hoard may still have recourse to reloading.

A cartridge consists of a brass case that holds a charge of powder, a primer, and a bullet. When a cartridge is fired, the primer is destroyed, the powder is burned, and the bullet is propelled from the gun. However, the brass cartridge case which remains, and which is the most expensive of the component parts, is practically as good as new. With a few tools and at small expense it can be made into a cartridge as good as the original. Some hunters have always reloaded their own cartridges; now others are turning to it or are having it done for them in some small shop brought into being by the scarcity of ammunition. One such shop is operated by F. R. Krause on a side street in Albuquerque, N. Mex.

When old Whale Blubber Ike up in Alaska wants some special kind of a cartridge that he can't find in his trading post, he is very likely to sit him down on a cake of ice and drop a card to Mr. Krause. And Mr. Krause is pretty sure to have just what he wants in stock, or, if he hasn't got it, the odds are ten to one he can reload a few of the correct size. Moreover he can fit them with hollow point, soft nose, copper jacket, or any style the old boy needs to knock off that polar bear that has been catching his sea gulls, for the Krause shop has the tools and experience to do the job.

It was in 1939 that Fred Krause moved into the garage he calls his factory, and began expanding a hobby that has turned into a business covering the entire nation. New Mexico had been his home for several years before that, during which time he was busy growing a new set of fibrosis for his old set of lungs. Having attended to that chore, he decided he would pick up a few honest dimes by reloading cartridges for some of his friends, and before he could back out on the proposition he found himself shipping cartridges to every state in the union. Copper had gone to war all right, most of it, but what was left could sure find a buyer if it was in the form of cartridges. In short, the war had administered a shot in both arms to the reloading business, and Mr. Krause was in it up to his front sights. So the business of reloading cartridges was booming, with a buyer on every post

card delivered to the Krause shop. But all was not smooth sailing. There were pressing problems to be solved, viz and to wit: How to get enough lead to make bullets; how to get enough tin and antimony to harden them; how to get enough smokeless powder to fill the cases; how to get primers, copper tubing, shell cases, and the other material necessary to run his factory.

The reloading of high-power ammunition, which is the kind turned out by the Krause shop, is something of a job, not only requiring special tools but also special skill. At least sixteen operations are involved in the reloading of a simple cartridge, one that does not have to be rebuilt in order to fit a different caliber. The sequence is as follows: All sediment is removed from the empty case and the primer is punched out with a special tool; the primer flash hole is reamed; the primer fouling is cleaned; a rapidly revolving brush of the correct size is inserted into each case to get rid of accumulations of dirt or other impurities. After that the mouth of the shell is reamed so the bullet will seat properly; the outside is cleaned with steel wool; the inner surface of the neck is lubricated with a special oil; dies and shell holder are put into the reloading tool; the outside of the case is lubricated; the shell is resized, neck expanded, and primer inserted; oil is wiped from outside and lubrication removed from inside neck.

Up to this point the operator has been busy getting the shell case ready for charging. Now he must ascertain the correct amount of smokeless powder necessary to produce the desired muzzle velocity for the caliber of case being loaded and the type and weight of bullet. This information is either taken from a chart made for the purpose or is known to the operator from actual experience. So he proceeds to weigh out the powder for the first charge of a particular lot of cartridges on a balance that is sensitive to within 1/40th of a grain, fills the powder measure, and then adjusts it so that it will throw the exact amount, as determined by the scale, into each shell case. That done, the bullet is seated with what is known as a bullet seater and the cartridge is wiped off and placed with others of the same type into a pasteboard box that is made by hand on the premises.

Bullets for modern guns are of many sizes, shapes, and weights, and are made of several different materials. More than 80 kinds are molded or finished in the Krause shop to fit more than 68 types of guns. There are hollow-point and soft-nose bullets intended to flatten out and tear a large hole in game. Copper-jacket bullets are popular for cartridges of high velocity. These are often made from copper tubing of varying sizes which is bought, traded for, or gathered in devious ways by the reloader. This is sent to a specialty shop in Colorado where it is cut into proper lengths, filled with lead, and run through a machine to size and shape the bullet. That shop also is struggling to keep up deliveries, and tubing shipped to it today to be converted into bullets may not get back for six months. Very few bullets are molded from pure lead because they are not suitable for high-velocity work. They are too soft to be rotated by the rifling in the barrel, thus tending to lead it up and to destroy accuracy. Tin and antimony are the common alloys that are mixed with lead to harden bullets.

In molding bullets, an electrically heated miniature furnace is used, augmented by a small blowtorch that plays its flame on top of the metal being melted. The furnace is equipped with a hand lever that may be operated to allow a thin stream of metal to pour into the mold, which has a capacity of from one to three bullets. As it does not take long for the metal to cool, the bullets can be turned out rapidly.

One of the big problems of the reloader is to get primers, the cuplike detonators of which there is one in each cartridge for the purpose of igniting the powder charge. Rifle primers and pistol primers are each of two standard sizes, of .210 and .175 inch. So far as size goes, a large rifle primer, for example, will fit a pistol cartridge that takes a large pistol primer, but it is not suitable for that cartridge because it is much stronger and of much heavier material. The same is true of the smaller primer. For that reason the reloader must carry in stock four different kinds of primers if he is to take care of the trade.

Back in the good old days before the war, primers were sold by dealers at about $3.80 per 1000, and a man could buy them hither and yon. Today it is different. Primers are now valuable merchandise, and scarce as hair on a frog. If the reloader can get some at $20 per 1,000, he snaps them up. Frequently he obtains a few from an individual who formerly reloaded his own cartridges and laid in a store while the laying in was good. So far there is little restriction on the buying of primers, powder, or any other reloading material; but a fellow has to be alert to keep himself supplied with what he needs, and the ceiling over the stuff is fairly elastic.

Brass shells for reloading are also hard to get, but there is consolation in the fact that one kind of shell case can be transformed into a cartridge for a different type of gun with the proper tools. For this purpose, according to Mr. Krause, there is no case made that equals the 30-06. The history of this type runs back to somewhere in the gay nineties. Up to about 1903 the U. S. Government used the 30-40 Krag rifle as its main arm for exterminating enemies. Then the Springfield was adopted with the new 1903 Springfield cartridge—the grandpa, you might say, of the present 30-06 cartridge which was born in 1906 when the neck of the Springfield was shortened a little.

This will be as good a place as any to

MEASURING SMOKELESS POWDER

The powder charge is determined with great accuracy and varies among cartridges of the same caliber in accordance with the weight of the bullet used. On the bench are empty cartridge cases in a reloading block and, beyond them, some remade cartridges with bullets set in place.

insert a few elementary facts regarding cartridges for the benefit of those who have never squeezed the trigger of a high-powered rifle. The 30 in 30-06 refers to the diameter of the bullet, which is approximately .30 inch (actually .308 inch). Similarly, a 250 Savage rifle fires a bullet about .250 inch across (actually .257 inch), and a 50-caliber machine gun shoots a bullet ½ inch in diameter.

The 30-06 is undoubtedly the most popular sporting gun for big game in this country for a number of reasons, the most important being the great variety of bullet shapes and weights available in this caliber. It is also used by the Army and Navy, but with this difference: while the Army fires full-metal case or solid-pointed, jacketed bullets in conformity with international law, sportsmen use soft-nose or hollow-point bullets that mushroom when they hit. The Government's standard bullet for the 30-06 gun weighs 150 grains, has a muzzle velocity of 2700 feet per second, and a maximum range of 3 miles, 184 yards. It will penetrate forty-seven 1-inch soft-pine blocks before expending its terrific energy.

Lightweight bullets have the highest muzzle velocities, other things being equal, and sporting-rifle cartridges are made in a variety of bullet weights to meet different requirements. The powder charge also varies in accordance with the bullet weight. Terminology designating powder charges does not mean much nowadays because it was originated when black powder was used exclusively. For example, the early 30-40 Krag cartridge contained a 30-caliber bullet and 40 grains of black powder. Since smokeless powder became available the charges have been altered, and there are now slow-burning and fast-burning powders, each of which has a different effect.

Weight of Bullet in Grains	Muzzle Velocity Feet per Second	Energy in Foot-Pounds	Penetration ⅜-Inch Pine Blocks
110	3380	2790	11
150	2960	2920	19
172	2700	2785	14
180	2600	2895	11
220	2410	2840	20

The 30-06 sporting gun is manufactured by several concerns and most of them offer individual ranges of ammunition for their own type, although any 30-06 cartridge will fit a rifle of that bore. The accompanying ballistic data are taken from current literature on Winchester 30-06 cartridges.

The 30-06 case, as has already been said, is a regular lifesaver for the reloader. It may start out in the Krause shop as a common old 30-06 like thousands of others, but end up as a 300 Savage rarin' to be shipped to old Whale Blubber Ike who will use it to control a walrus infestation in Alaska. Mr. Krause once got an order from the gun editor of a national sporting magazine for 100 cartridges to fit his Whalen rifle. Now the Whalen is what is known to the trade as a wildcat, and its owner was probably having a hard time finding shells. He was thoughtful enough to send along the empty cases for reloading, so it wasn't much of a job to fill them up and to return them to him.

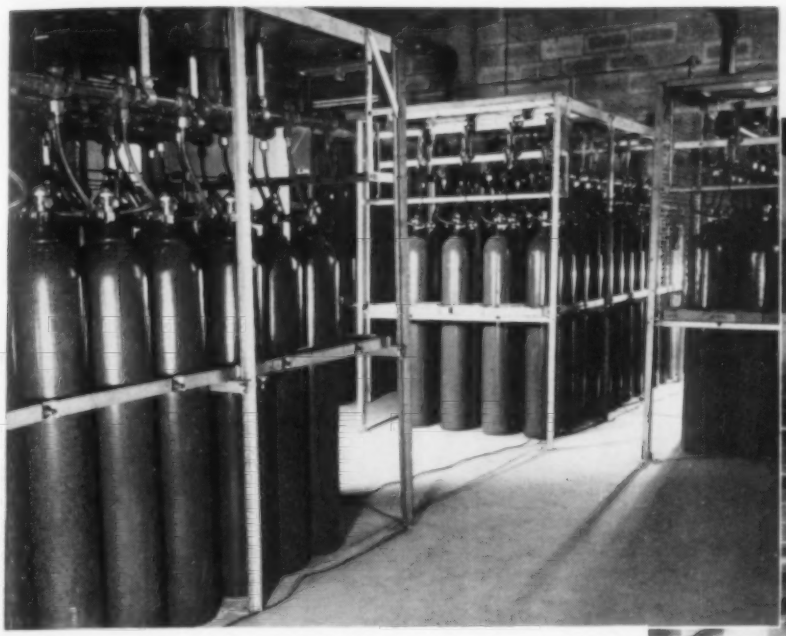
By running the 30-06's through the proper tools and doing a few things to them that nobody but an expert knows how to do, they may also be converted into cartridges for a 257 Roberts, a 250 Savage, an 8 mm., a 7 mm., a 25 Neidner, another wildcat, or even for a slick-shooting 228 Ackley Magnum, a special gun built for a special customer who wants it for a special hunting trip after special game. But that isn't all a good reliable reloader can do with a bunch of 30-06 shell cases. Take for instance the Varminter. That little baby will exterminate a lot of varmints with cartridges made of 30-06 cases that never thought they would be turned into ammunition to fit a 22. And don't get the idea that the Varminter is a little popgun good only for rats. In a recent issue of a national sporting magazine is the story of Jack Holliday who knocked off a grizzly bear with one of those rifles.

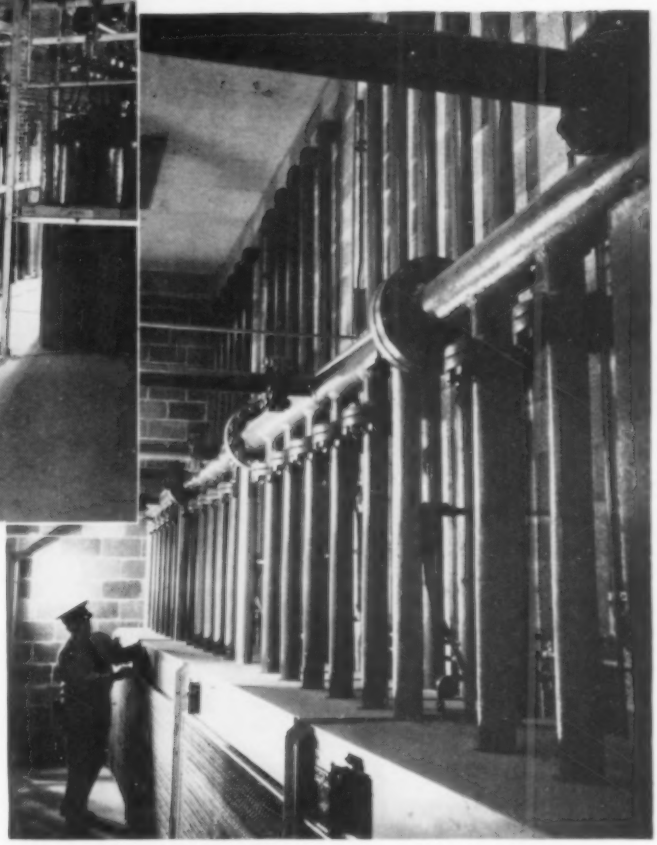
The market for reloaded shells is not a local one, as an inspection of Mr. Krause's books will show. He has reloaded eight hundred 30-30's for the Government and sixty thousand 38 specials for the state police of New Mexico. County sheriffs and constables come to him for cartridges; Dodge City, Kans., gets a shipment of 30-30's; Burley, Idaho, wants some 300 Savages; and the city of Elgin, Ill., craves a supply of high-power, soft-nose 30-40's. Nobody but the customer knows what will be done with that high-velocity ammunition; but, just the same, the Krause plant goes into action, and before you know it reloaded cartridges are on the way.

The sportsman is a strange and clannish breed. He strides forth in the morning full of optimism and hot coffee and faith in his peep sight. But he may return at night with an empty belly, an empty game bag, and with every tired muscle in his body yelling bloody murder. But he loves it! And because he loves it the Krause reloading shop in Albuquerque is working sixteen hours a day. Most of the business comes in from the sportsman's grapevine that works while you sleep. One small reloading ad run by Mr. Krause brought from 20 to 30 letters a day. There was even one from South America, which also has been hit by the ammunition shortage. These are the methods that have brought to Fred Krause's shop on a back street in Albuquerque N. Mex., orders for cartridges all the way from Alaska to Florida and Texas to Maine.

MOLDING BULLETS

The metal, a mixture of lead, tin, and antimony, is melted in a small electric furnace and drawn into a mold by operating a hand lever. In the background are some cartridges of 22 caliber, of which twelve different types are reloaded in the shop.





SEVEN TONS of CARBON DIOXIDE Guards Naval Stores from Fire

SOURCE OF GAS

The carbon dioxide, in liquid form, is stored in 280 steel cylinders arranged in five banks of 56 each. Some of them are pictured at the left before the protective housing was put up. The other view shows the large-size manifold piping that carries the gas from the routing-valve frames to the distribution system leading to the areas under protection.

A CARBON-DIOXIDE fire-extinguishing installation in the Aviation Material Storehouse of the Naval Storage Depot in Philadelphia, Pa., protects every part of that building, which is 577x119x17 feet in dimensions. Only a few years ago a system of this size was considered impractical, especially as the contents of the structure are highly flammable and include liquids which, if ignited, have to be quenched with great speed in order to prevent a disastrous fire. In this instance, it was found possible to provide satisfactory protection by using multiple nozzles that can blanket the building with inert carbon dioxide quickly and thus reduce the oxygen content of the air to a degree that will not support combustion.

The depot is one of a series of naval supply centers that are scattered throughout the country to keep aeronautical supplies flowing steadily to domestic and foreign air bases where Navy planes are stationed and serviced. Large stocks of parts, plane sections, and miscellaneous supplies of all sorts are on hand there, ready to be sent out at once after they are requisitioned by the fields. The storehouse is one of a dozen buildings at the Philadelphia depot. It is divided by concrete-and-steel walls into four spaces which are connected by self-closing fire doors. In the rooms are stored paints, oils, greases, glues, dopes, lacquers, and other flammable liquids of which large quantities are required for airplane use. They present an enormous fire hazard, and the means that have been set up to safeguard them constitute what is termed the largest built-in carbon-dioxide fire-extinguishing system in existence. It was provided by Walter Kidde & Company.

The system consists of a central supply of carbon dioxide, of piping to deliver it to all parts of the four rooms, and of nozzles to discharge it. The carbon dioxide, in liquefied form, is contained in 280 steel cylinders, each of which holds 50 pounds. Upon release, it becomes gaseous, expanding to 450 times its original volume, and the entire 7 tons can be directed by valves into any one of the four spaces. It is claimed that such a blanket would smother even the fiercest fire in a few seconds. The cylinders are manifolded in five frames containing 56 each, one acting as a master control frame. There are four valve-frame assemblies, each having five automatically actuated directional valves which, in the event of a fire, send the gas to the particular space involved. Because of the importance of stopping the circulation of air in the presence of fire, each valve frame has two plunger-type switches that are operated by the valves—one to close a circuit and to sound an audible alarm and the other to open a second circuit that stops the ventilating fans and shuts the louvers so that air will not feed the flames.

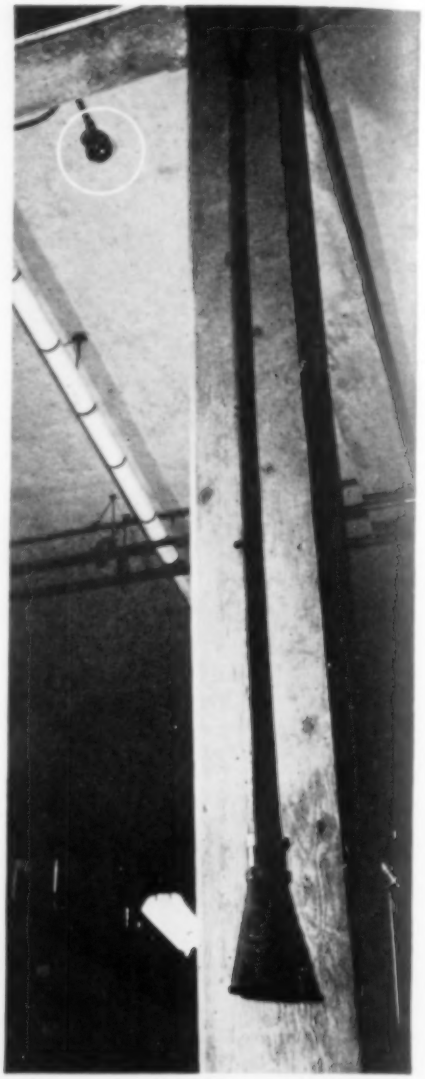
Five supply lines lead from the valve-frame assemblies to each of the four protected spaces, where they terminate in a total of 296 shielded discharge nozzles. Each of these is located at a point on a concrete upright or post one-third the distance from floor to ceiling and at other strategic places in the storage rooms. The nozzles deliver the gas from the piping system without any high-velocity jet effect such as might be produced with unshielded nozzles. They prevent objectionable turbulence and positively control the fire-extinguishing gas, forming a blanket that is built up

from the floor, thus providing the highest concentration at the base of the flames and quenching any spill fire. Twenty-four pressure-operated trips are incorporated in the supply lines to operate the self-closing doors. Passage of the carbon dioxide through the piping retracts a pin, releases control weights, and allows the particular doors to close, thus confining the fire to one room, preventing fanning of the flames, and localizing the gas.

Spotted about the ceilings at regular intervals are 48 heat actuators that become active when the temperature in the rooms exceeds a predetermined point. Heated air rises to the ceiling and, if of sufficient intensity, expands the air in the actuators, causing pressure waves to pass through the tubing to a release mechanism located at the directional valves. Instantly weights drop, opening the proper directional valves, ringing the alarm gong, shutting off the fans and louvers, and starting the time-delay mechanism which allows 35 seconds to elapse before seals are cut and the gas is discharged, giving workers sufficient time to leave the rooms. Carbon dioxide, while nonpoisonous in itself, prevents the required amount of oxygen from reaching the lungs, just as it prevents it from feeding the fire, and a person therefore cannot long retain consciousness in a space filled with the gas. The warning signal sounds continuously during the 35-second interval before the gas is released. Each room is provided with two break-glass remote-control pull boxes that are located at the exterior doors. If a blaze should be detected before the heat actuators work, a pull on the handle of either will set off the system by means of a cable running back to the valve frame serving that space.

The Kidde fire-extinguishing system uses carbon dioxide under high pressure —850 pounds per square inch at 70°F. This means that the gas is delivered through the piping and all the nozzles in a room simultaneously, its tremendous expansive force upon release doing away with the need of a pump or any other extraneous force. Reduction of the normal atmospheric-oxygen content from 21 to 16-15 percent suffices to put out a fire of ordinary flammable liquids and is effected by this system in the shortest possible time. The entire 7 tons of carbon dioxide is discharged within approximately one minute.

Carbon dioxide does not combine with the products of combustion even in the presence of heat and leaves no residue or mess to be cleaned up. It does not deteriorate with time nor freeze, and it does not cause corrosion. The only attention the system requires is the recharging of the cylinders. The latter do not need much storage space because the gas is highly compressed, and their placement is a matter of convenience. In the Aviation Material Storehouse the cylinders and routing-valve frames are housed in a maintenance room that has a floor space of about 25x33 feet and is located alongside one of the long walls of the building at a point approximately midway.



ACTUATOR ON CEILING

Spaced at regular intervals on the ceiling of each room are actuators that respond to a rise in temperature. If a fire starts, the heat expands the air in the actuators, causing a pressure wave to pass back through piping to operate a release mechanism at the directional valves. Instantly a gong warns workers to leave the rooms, louvers and fans are shut off, and within 35 seconds gas starts to flow into the area concerned. This picture shows an actuator encircled in white and a gas-discharge nozzle on the post in the foreground.

NOZZLE DISTRIBUTION

One of the storage spaces for highly flammable materials, showing gas-discharge nozzles arranged in sprinkler fashion on the concrete pillars. Other nozzles are placed against the walls. Each room has approximately 80 gas outlets.

Peru's Ocean-to-Amazon Highway

A NEW highway across the Andes in Peru is not only of outstanding interest because of its engineering features but also of great importance to the war effort because it taps an area that is supplying the United Nations with rubber, drugs, and other needed raw materials. The road extends from Lima, on the Pacific Ocean, to Pucallpa on the Ucayali River, which is a tributary of the Amazon and is navigable by small boats. Traffic flows on the Ucayali between Pucallpa and Iquitos—bustling Amazon River port that is the center of the region whose natural resources are being drawn upon heavily today.

The trip of 1172 miles from Lima to Iquitos is now made in five days—two by automobile and three by boat—and at a cost of only $17. Prior to the completion of the highway it was a 30-day journey by muleback and canoe, and was so arduous that many travelers preferred to take a boat up the Pacific Coast, through the Panama Canal, down the Atlantic Coast to the mouth of the Amazon, and thence up that stream to Iquitos, a distance almost ten times as great. The new traffic artery provides a direct route across South America and connects Lima with the entire Amazon River valley, which embraces some 22,000 miles of navigable streams.

The first section of the road—a stretch of 116 miles between Lima and Oroya, on the central plateau of Peru—has been in service for several years and is surfaced with asphalt. It is rated as one of the most spectacular pieces of highway construction in the world. For the first 87 miles it twists and turns through a series of narrow and steep canyons, rising until it reaches Anticona Pass at an altitude of approximately 16,000 feet. This is nearly 1000 feet higher than Mont Blanc, the loftiest peak in Europe, and 1500 feet higher than Mount Whitney, the greatest elevation in the United States. At one point in the course of the climb the road crosses and recrosses itself on high trestles to form a double loop that is reputed to be the only one in the Americas. From the summit of the Andes it descends to an average elevation of 13,000 feet, and then snakes its way across the mountain ridges to Cerro de Pasco, one of the most important copper-mining centers in the Western Hemisphere. From there it drops steadily to Huanuco, 260 miles from Lima and some 6000 feet above sea level, where the Government has built a modern hotel with accommodations for 62 overnight guests.

Continuing eastward from Huanuco, the highway traverses some of the lesser ranges of the eastern Andes and descends into the tropical valley of the Huallaga River and to the frontier town of Tingo Maria which, only a few years ago, was no more than a collection of thatched huts that marked the end of the trail. Now it is becoming a place of importance. It has a new hotel, a 40-bed hospital, a $160,000 government agricultural station, quarters for various governmental officials and administrative officers, a modern school, two sawmills, warehouses and stores, and traffic on the Huallaga River is active. United States technicians aided in establishing the agricultural experiment station which is engaged in improving the production of quinine, kapok, quinoa, and barbasco —all of which are native to the region, as well as of tea, jute, and abaca from which manila fiber is obtained.

Beyond Tingo Maria are the heavily forested Blue Mountains. There the designing engineers were faced with the problem of routing the highway from a valley 2200 feet above sea level up to and over a 7000-foot range and down to the River Ucayali. Apparently there was no pass through the mountains, but someone remembered that the Franciscan missionaries had explored the region centuries ago during their efforts to convert the Indians. Knowing that they must have discovered a way through the mountains, the engineers searched through the dusty church archives, and in the spring of 1937 Engineer Federico Basadre came upon the records of Fray Alonso Abad. These consist of twelve closely written volumes, and in them is a description of a long and exhausting search through the uninhabited jungle for a break in the Blue Range and a pass to the Amazon.

"In the spring of 1757," the old diary states, "we organized a new expedition, leaving the Indian village of Cuchero on May 4 with 17 Indians and arriving on May 15 at Tulumay, and, following the directions of a previous expedition, we discovered, on the 25th day of May, the 'Paraja' where a passage seemed to open in the broken country which led to a gorge or canyon leading in the direction of the forest-covered Pampas of Sacramento (or Amazon lowlands)."

Following the directions that had

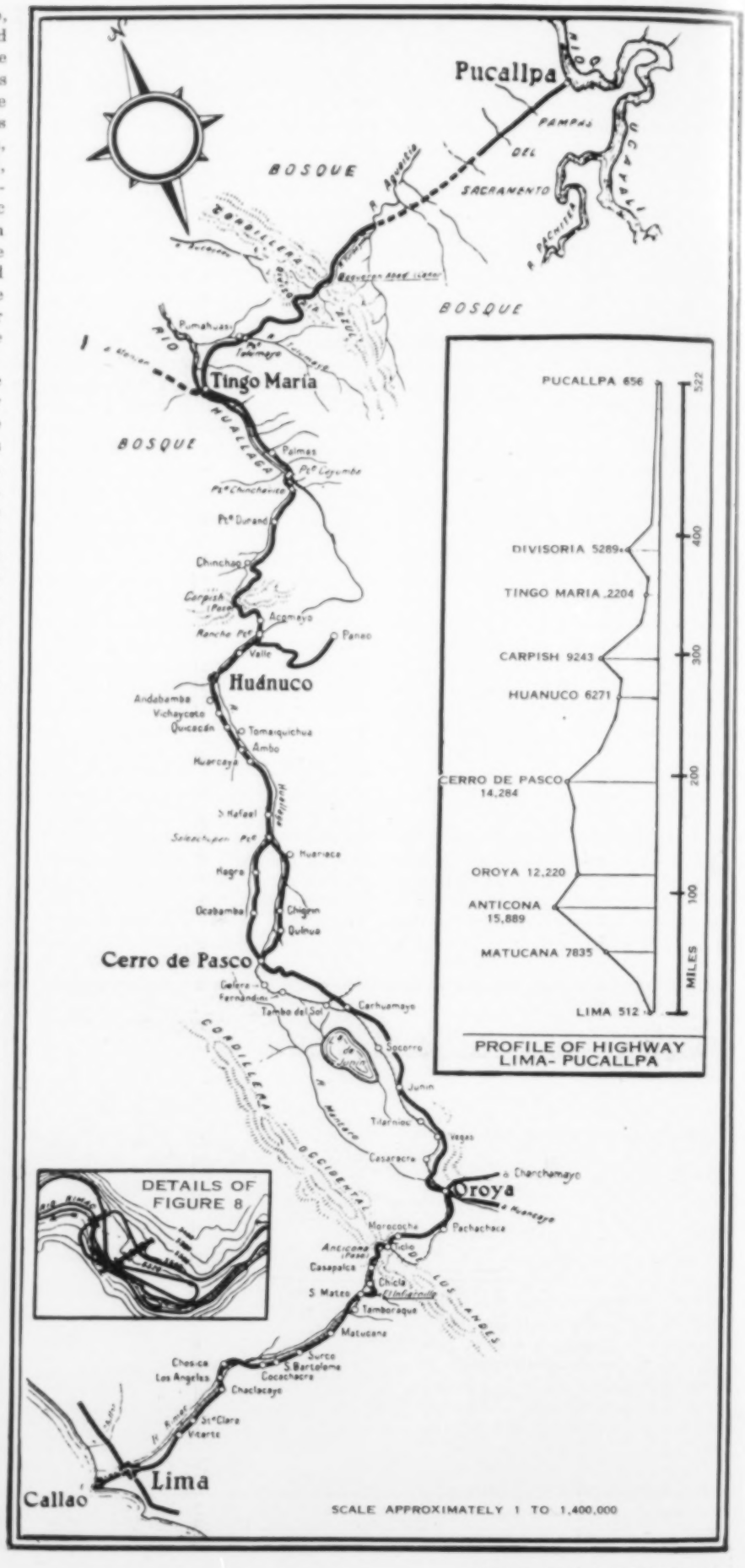
THROUGH ROUTE FROM LIMA TO THE ATLANTIC

been written nearly 200 years ago, Basadre found the same gap that had been cut through the Blue Range by the Yuracyacu River. No other person has been known to make the passage in the centuries that have intervened, as this part of Peru is uninhabited. The canyon, which has been named after Padre Abad, is a deep, narrow fissure in the mountains that were created by some seismic disturbance in ages long past. It is a little more than 3 miles long, not more than 300 feet wide in some places, and 6000 feet deep. Three tunnels and three bridges had to be constructed in order to get the roadway through alongside the river.

After leaving the Abad Canyon, the highway crosses the River Aguaytia by ferry. Later, a 2560-foot bridge will be built there. The route then continues across the forested lowlands to Pucallpa. Only a frontier village five years ago, Pucallpa gives promise of becoming the metropolis of eastern Peru. It already has an airport, a hospital, a school, and other modern buildings. Steamers towing barges now ply the Ucayali between Pucallpa and Iquitos, a stretch of some 650 miles. Ocean-going craft not exceeding 6000 tons come up the Amazon to Iquitos, a distance of 2300 miles from the Atlantic.

A regular overland mail and parcel-post service has been established between Lima and Iquitos, and the first truck made the 522-mile run to Pucallpa at an average speed of 37 miles an hour. Passenger buses make the same trip in two days, with an overnight stop at Huanuco. Completion of the road, which is an important auxiliary of the Pan American Highway System, is credited to the interest and driving force of Don Carlos Moreyra y Paz Soldano, Peru's Minister of Public Works and Development.

Aside from the aforementioned resources of the area that have been opened up by the new route, petroleum was discovered six years ago 50 miles from Pucallpa and only 20 miles from the highway. It is the only known dependable source of oil in the entire Amazon valley. A small topping plant has been erected at the field, and it is now supplying monthly 2000 barrels of gasoline and oil, which is shipped in drums to Iquitos and to nearby points in Brazil. Oil is important to the development of the Amazon River section, for it is estimated that 5000 motor-driven vessels will be required within a few years to handle the traffic.



LIMA-PUCALLPA ROAD

This 522-mile stretch from the Pacific coast to the headwaters of the Amazon is a fine example of modern highway construction. Details of a figure-eight loop wherein the road crosses itself twice on trestles are shown in the small inset.

Modern Battleship Armor

WITH pardonable pride, the nation's steel industry is taking a bow for its contribution towards making the new *U.S.S. Missouri* the "largest, heaviest, and toughest battleship in history." Launched, but not yet commissioned, the great craft is now being fitted out to take her place in the fighting line. When she is ready, she will probably be the heaviest vessel afloat, and steel will account for 95 percent of her weight.

Complementing the fire power of her 16-inch guns which will deliver 10 tons of projectiles with each salvo, the *Missouri* will be sheathed with the finest coat of protective armor ever applied to one of our ships. Although it will cover a goodly portion of the sides, the greatest expanse will face the sky, being distributed over 418,000 square feet of decks and platforms.

According to the *Iron and Steel Institute*, the vessel will contain virtually every kind of steel made, "ranging from aristocratic stainless fixtures in her cook's galley and in her surgery to common structural shapes. A list of all the steel compositions specified would cover practically the entire field of steel metallurgy." The *Missouri* was planned two years before we entered the war, and at the time her keel was laid early in 1941, when she was called the *BB63*, some 1500 tons of steel plate and other products had already been turned out and delivered by our steel mills.

The armor with which this dreadnaught will be clad is the result of more than 50 years of development by our steel industry. Armor plate is made resistant to projectiles by hardening it from the surface inward by a carbon-infusion process. The method was invented in 1891 by an American, H. A. Harvey, and was afterward improved upon by the German firm of Krupp. A slab from a 14,000-ton hydraulic forging press weighing 30 tons or more is heated white-hot on its upturned surface and then covered with coal dust. Another heated slab is laid on top of it, and the gigantic "sandwich" is soaked for three weeks at a temperature of 2000° in an annealing furnace while the carbon from the coal dust seeps into the pores of the two slabs. After a cooling period, the slabs are split apart and streams of cold water are directed against their surfaces, blasting off the excess coal deposit and freezing the absorbed carbon in the steel, thereby hardening it. The depth of hardening is determined by the amount of chromium melted into the steel at the time it is produced.

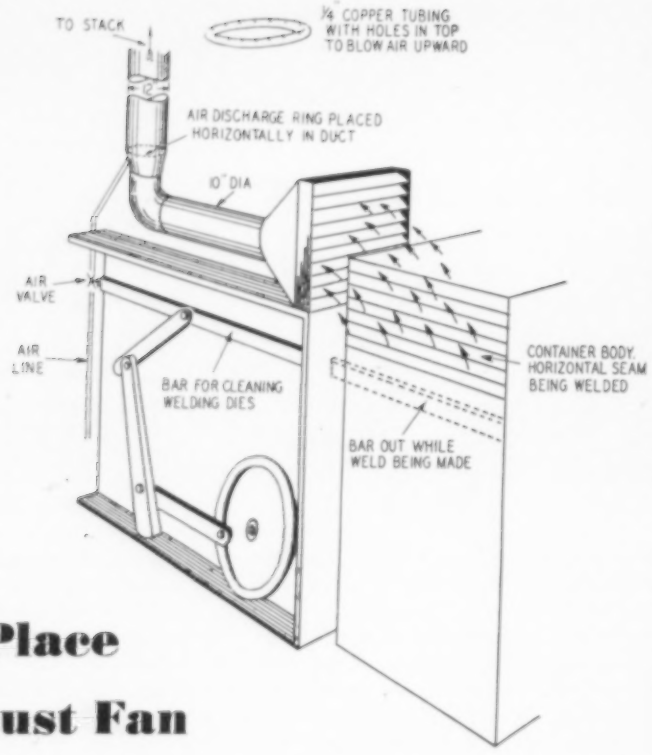
In all, it takes five months to make the side or "belt" armor by the method just described. As this armor is too hard and inflexible for deck service, American metallurgists have developed deck armor that "rolls with the punch," that yields without cracking and is capable of deflecting projectiles or bomb fragments that strike it at an angle. Its properties result from the proper proportioning of certain alloying metals.

Hundred Years of Telegraphy

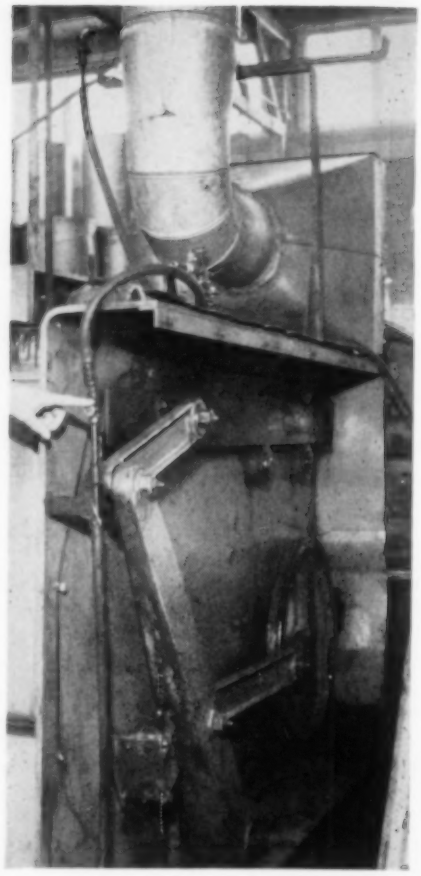
THE centennial of the telegraph will be observed in Washington on May 24. On that day a memorial plaque, provided with funds appropriated by the Congress, will be unveiled to its inventor, Samuel F. B. Morse, in a room of the Capitol that is now used as a law library. In that same room Morse sat at a crude telegraph transmitter on the morning of May 24, 1844, and tapped out the historic message, "What hath God wrought!" while a group of notables, including Henry Clay, Dolly Madison, and government officials, looked on. In Baltimore the message was successfully received by Morse's colleague, Alfred Vail. Skepticism over the invention vanished immediately, and the way was opened for the development of the imposing system of wired and wireless electric communication that now criss-crosses the world. The scene that typified the birth of the telegraph will be reënacted as a part of the ceremonies.

It took Morse a long time to convince a doubting populace that telegraphy was practical. He conceived the idea in October, 1832, while aboard ship returning from Europe, and before he reached New York he had made plans for a telegraph recording instrument and for the dot-dash-space code that now bears his name. A conversation with a fellow passenger concerning Faraday's publication on magneto-electric induction initiated the train of thought that resulted in the invention. Three years later, Morse constructed a one-way experimental model, and in 1836 he built a duplicate set so that messages might be sent in either direction. Exhibition of the first model at New York University in 1835 enlisted the interest of Vail, who rendered valuable aid in putting telegraphy on a working basis.

On February 21, 1838, Morse demonstrated his telegraph before President Martin Van Buren and his cabinet, and this led to a congressional appropriation of $30,000 for a series of tests to determine its practicability. During the following year an experimental line was opened between Washington and Baltimore, a distance of 40 miles. It was used successfully for transmitting business messages, but when Morse offered his invention to the Government for $100,000 he was turned down because the postmaster-general expressed doubt that "the revenues could be made equal to the expenditures." Thereupon Morse organized a private company that constructed the line over which the message of May 24, 1844, was flashed. Within seven years, 50 companies using the Morse patents were operating in the United States, and in 1861 the first of similar lines was put in service in Europe. Meanwhile, the first transatlantic cable had been laid. More than twenty now cross that waterway, and there are some 3500 submarine cables in the world exceeding 300,000 miles in length.


TO STACK
¼" COPPER TUBING WITH HOLES IN TOP TO BLOW AIR UPWARD
AIR DISCHARGE RING PLACED HORIZONTALLY IN DUCT
10" DIA
AIR VALVE
AIR LINE
BAR FOR CLEANING WELDING DIES
CONTAINER BODY. HORIZONTAL SEAM BEING WELDED
BAR OUT WHILE WELD BEING MADE

Air Jet Takes Place of Exhaust Fan



AUTOMATIC OPERATION

The sketch explains the equipment employed and how the plunger bar operates the air valve when it is drawn back. The photograph shows the plunger bar in its outward position and the finger points to the air valve that it contacts. The air line may be seen passing upward to its connection with the discharge ring inside the exhaust duct.

IN A PINCH, a compressed-air aspirator will satisfactorily replace an exhaust fan, as a western barrel manufacturer found out while engaged in turning out metal drums on a war contract. One of the first steps in the operations is to flash-weld the body seams of the containers, and this creates fumes and produces fine metal particles. For the health of the workers, these have to be removed, and under normal circumstances the logical equipment for the work would have been an exhaust fan. However, no fan was available, and none could apparently be obtained for weeks or maybe months. So an air-operated evacuation system was rigged up.

An exhaust funnel was set up at a point where it could collect the air from around the welding apparatus and was connected with a duct leading out through the roof. Inside this duct was fitted a discharge ring of ¼-inch copper tubing in the top of which were drilled holes to serve as outlets for compressed air piped to the ring from the plant distribution system.

The exhaust is arranged to operate automatically. After each weld is made, a motorized mechanism thrusts a cleaner bar through the dies, as indicated in the accompanying sketch. This bar or plunger is retracted while welding is in progress, and in this position contacts and opens an air valve, admitting air to the discharge ring. The suction thus induced draws the offending air into the funnel and carries it up through the duct. When the bar is thrown forward to perform its cleaning function the air valve is closed, for during this phase of the welding cycle no fumes and no particles have to be removed. This is the case approximately one-third of the time and results in a considerable saving of compressed air.

Blueprints That Will Pass Muster

BLUEPRINTS rejected because of insufficient contrast in the original drawing have been one of the headaches of engineers, architects, and designers. We say "have been" because a cure has apparently been found for the headache by Douglas J. Wishart of The Glenn L. Martin Company. He has invented through sheer necessity—shortage of draftsmen for heavying up lines—what he calls a Legimeter. This device predetermines whether or not a drawing will reproduce satisfactorily while it is still in the hands of the draftsman, or, in the case of an old drawing, before it goes to the blueprint machine.

The Legimeter consists of a 2-panel illuminated table. In the first panel are samples of drawings which have been selected as standards of minimum satisfactory contrast. The second is a clear sheet of ground glass on which is placed the drawing to be evaluated. Both panels are illuminated by light of the same intensity, and it is therefore possible for the draftsman to tell at a glance whether or not his drawing meets requirements. If not, he can heavy it up on the spot. Accuracy of evaluation is assured because it is made by transmitted rather than reflected light, the same as is used in producing blueprints.

An added feature of the Legimeter is a 3-panel backboard for the instruction of inexperienced draftsmen. The two outside panels are illuminated by transmitted light and contain, left, examples of acceptable drawings and, right, unsatisfactory drawings. In the recessed center panel, which is illuminated by reflected light, are blueprints made from these drawings—prints which have actually been accepted and rejected by the Army. Besides graphically demonstrating what happens when a drawing lacks contrast, the backboard is an ideal means of showing novices the difference between a drawing that will reproduce properly and one that may be clear in itself but provide faint and partly illegible blueprints.

Electric Utility Cleans With Air

COMPRESSED air is used for cleaning the equipment of one of the nation's large electric-light and power companies, a midwestern concern that operates several generating plants and many substations. A huge amount of apparatus must be kept free of dust to assure good contacts and smooth transmission of current. This task is handled by a specially trained crew, which goes from one station to another, giving each a periodic cleanup.

As the accompanying picture shows, the dust is blown from the equipment by a blast of air, a long tube of nonconductive ceramic material fastened to the end of an air hose serving as a blower nozzle. It is important that there be no moisture in the air, as this would create arcs and cause dissipation of the current. The air also must be free from oil and dirt. The supply taken from the plant system is therefore dried and cleaned by passing it through an Aridifier. This unit is mounted in a portable frame interposed in the hose line.

The Aridifier is a product of the Logan Engineering Company and accomplishes its work by means of centrifugal force. It contains no filters and consequently cannot become clogged. It is suitable for application wherever clean, dry air is required. One aircraft manufacturing company, for example, has 500 units in service.

Vacuum cleaners likewise are employed by the power company in its cleaning operations, but their use is limited to collecting the dust that is blown to the floors. They are not adapted for direct cleaning because of possible hazards resulting from contact between the metal in the nozzle and any part carrying current.

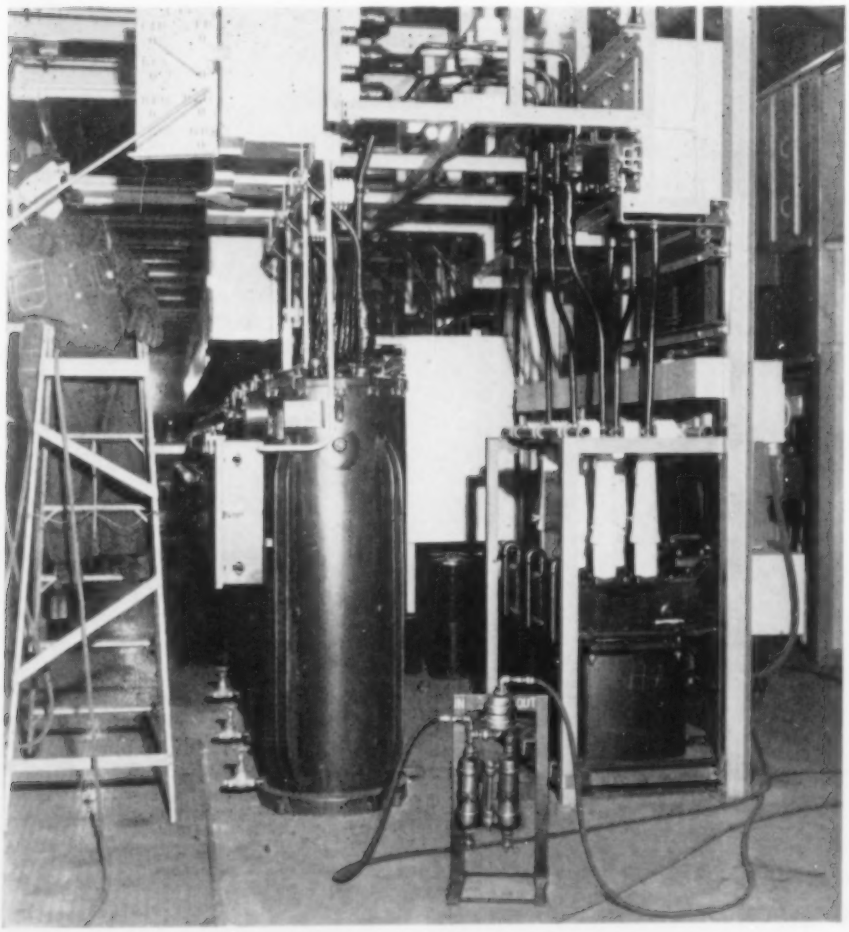
COOLED BY COMPRESSED AIR

One of the new searchlights with the rear door open. The latter gives access for relamping and serves also as a support for the silvered-glass reflector. In case of accidental opening of the door while the lamp is in operation, a safety switch extinguishes the arc.

Air-Cooled Searchlight

SOMETHING unique in searchlights has been announced by the General Electric Company. Its light source is a midget, capillary-type, 900-watt mercury lamp which throws a flat concentrated beam capable of illuminating distant horizontal surfaces from a low mounting height. When burning, it is necessary to cool the lamp because the heat has a tendency to create high internal pressure which, if not reduced, would extinguish the arc. Cooling is done by compressed air from which any entrained oil and moisture is removed and which is continually fed by a rubber hose into the top of the searchlight drum. Air at 25 pounds pressure is used and is furnished at the rate of 6 cfm. by a compressor driven by a ¾-hp. motor. Before the light goes on, a pressure switch insures the delivery of an ample supply of cooling air.

The new searchlight is available in 12-, 18-, and 24-inch diameters with measured maximum candle-power values ranging from 7,500,000 for the 12-inch unit to 32,000,000 for the 24-inch. The smallest of them is said to provide four times the candle-power of an incandescent searchlight of the same size. Mountings are of various types suitable for use on land and shipboard.



ELECTRIC-COMPANY "HOUSEKEEPER" AT WORK

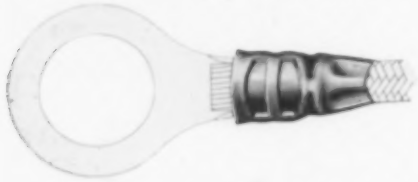
The man on the ladder is using a long ceramic nozzle to direct a blast of compressed air in cleaning the apparatus in a substation. On the floor is a portable Aridifier which cleans and dries the air prior to its application.

Waterproof Paper Bags

TO MEET the needs of the Quartermaster Corps, the Bemis Brothers Bag Company and the American Cyanamid & Chemical Corporation have developed a multiwall paper shipping sack that is said to protect its contents during outdoor storage and to withstand rough handling when soaking wet. The bags are made of asphalt-laminated paper treated with melamine resin that gives it high wet strength and resistance to scuffing when wet. Further, both top and bottom closures are of flannel-lined cotton tape stitched in place by a sewing machine. When each bag end is dipped in amorphous wax to waterproof it, the cloth acts as a wick and draws in the wax, thus forming an effective seal the entire length of the stitching.

Industrial Notes

Tight electrical connections without the use of a soldering iron, solder, and flux are being made in war industries by means of a new type of insulated terminal connector invented by Aircraft-Marine Products, Inc. There are different connectors to fit different jobs and, with the wires inserted, are converted into a homogeneous mass just by crimping with a hand tool or, for quantity production, by press dies. The result in either case is said to be uniformly good from the standpoint of tensile strength, voltage loss, and resistance to corrosion. The new method has a wide field of application and can be used in places that are too cramped to permit conventional soldering. A single terminal size will accommodate a wide range of wire sizes.



SOLDERLESS WIRING

The strands of wire are firmly sealed in the connector by press dies or by a crimping tool that looks like a pair of pliers. Insulation is bonded to the terminal, thus eliminating the need of insulation sleeving.

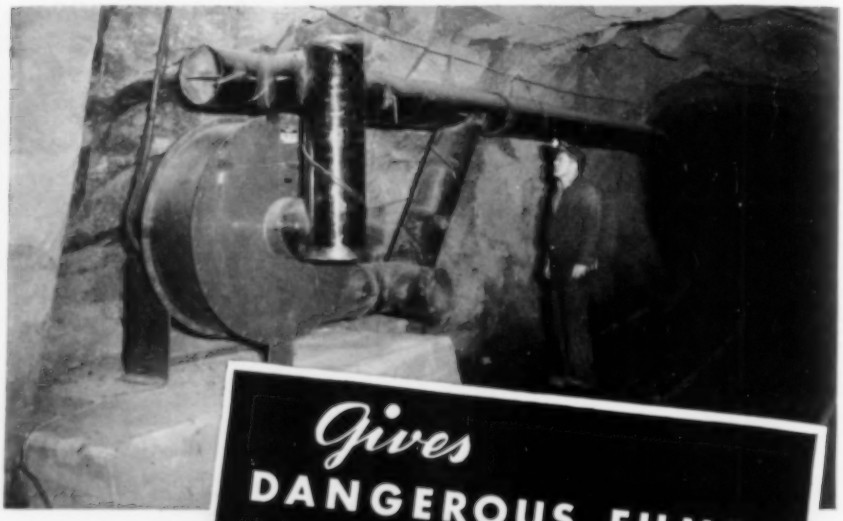
Motor-Mend is a liquid offered by E. I. du Pont de Nemours & Company for sealing cracks in cylinder heads, engine blocks, water jackets, and valve ports. It is poured into the radiator inlet of the engine cooling system when hot, a 1-pint bottle sufficing for a unit with a maximum capacity of 7½ gallons. As it circulates, it fills crevices, hardening and effecting what are said to be permanent repairs.

Safe Earthmoving is the title of a 35-mm. sound motion picture that is available for free showing both here and abroad. It has been made especially with the contractor and construction worker in mind and shows both safe and hazardous practices in the operation of earth-moving equipment. Running time is thirteen minutes. Copies may be borrowed from R. G. Le Tourneau, Inc., Peoria, Ill., or any of the company's dealers.

Carbon-steel pipe of ordinary weight and construction lined with an insulating material known as Insidline will, it is said, withstand pressures at temperatures exceeding 1000°F. The insulation is the product of Baldwin-Hill Company and consists of felt with a base of diatomaceous earth reinforced with asbestos fibers. The material is protected by metal liners that are arranged so as to provide for adequate expansion with a minimum of heat flow through the metal. Composition and thickness are varied in accordance with operating conditions. It is claimed that pressure piping of this type does not require the usual number of expansion joints, bends, etc.

Gases and vapors invisible to the human eye are detected well-nigh instantaneously, it is claimed, by a new electric eye that has been developed to give warning when dangerous concentrations of them are present in industrial or processing plants. Known as the ultraviolet photometer, it can be used to take grab samples or to run continuously.

Spread in small amounts over the fire bed of a coal furnace, Soot Destroyer, a product of the S & E Chemical Company, is said to keep furnace walls, boiler tubes, and smoke flues free from soot. The chemical volatilizes and acts as a catalyst, reducing the soot's ignition



CHECK THESE NAYLOR PERFORMANCE ADVANTAGES

- Always accurate in diameter.
- Concentric ends match correctly.
- Easier to install.
- Holds true cylindrical form.
- Stays tight and leakproof.
- Stronger — safer.
- High salvage value.
- Light weight saves steel.
- Cuts maintenance costs.
- Saves money.

Sizes: 4" to 30" in diameter—all types of fittings, connections and fabrications.

POST-WAR VENTILATING JOBS CALL FOR NAYLOR

LIGHT-WEIGHT PIPE

There are three sound reasons why Naylor is the preferred pipe for push-pull ventilating service. It is light in weight. It is leaktight. And it is stronger, thanks to the exclusive Lockseam Spiralweld truss that runs the length of the pipe.

Add to these advantages the practical savings of Naylor lightweight pipe and you can see why so many experienced operators depend on this distinctive pipe for permanent as well as temporary ventilating lines.

Naylor

LOCKSEAM SPIRALWELD PIPE

NAYLOR PIPE COMPANY

1245 East 92nd Street
Chicago 19, Illinois

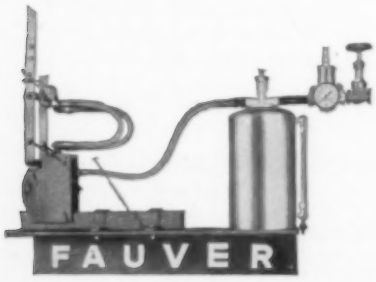
point. It will burn at 650-750°F., passing out of the chimney as a white fume while the residue drops as a fine ash. For each 25 hp. of boiler rating, one pound of the compound should be used in 2-week intervals.

Antifouling paint now being tested under service conditions is said to prevent barnacles from cementing themselves to the hulls of ships, thus eliminating the need of dry-docking them for their removal.

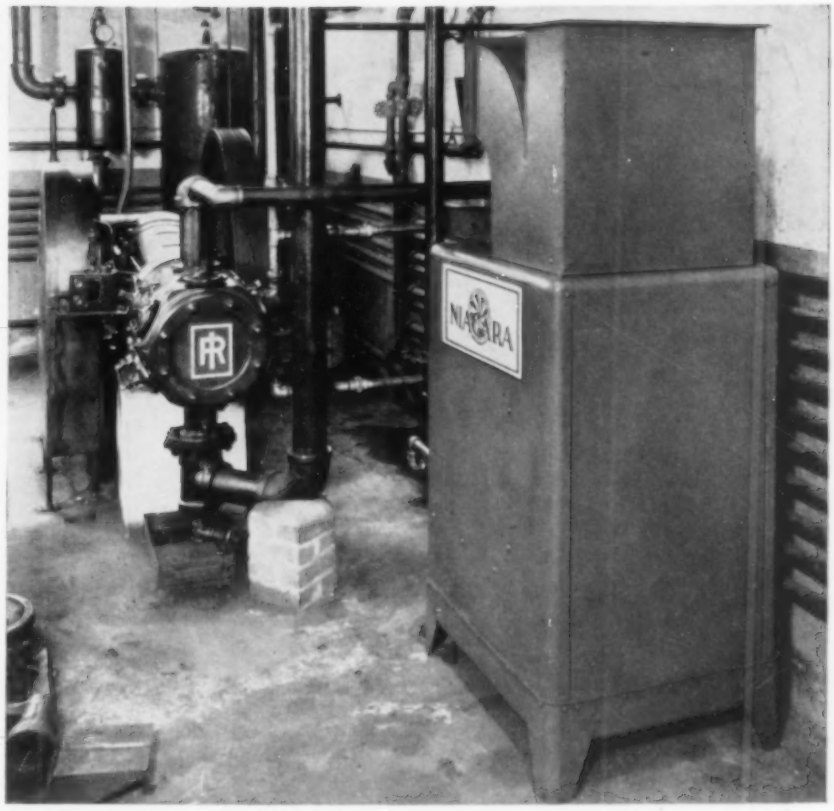
For the extension of drills and the use of broken drills, Topflight Tool Company is offering an adapter equipped with a self-locking device that is said to center and hold a drill firmly and to eject it easily. It is available in practically any required length.

Cosmoline No. 805, a new E.F. Houghton & Company preparation, is intended for use on finished metal surfaces to neutralize the effect of acid perspiration from workers' hands and as a protection against the corrosive action of high humidity, fumes, and chemical atmospheres. The liquid conforms to the requirements of Ordnance Technical Manual TM 38-305.

Ordinary conveyors and trolleys traveling usually not more than 10 feet a minute have been automatically lubricated for years, but not until of late has it been practicable to do the same thing in the case of high-speed equipment such as transfer tables that serve to carry hot and cold armor plate and ingots in a steel mill. The chains of these transfers travel at speeds up to 160 feet



a minute and under temperatures reaching a maximum of 500°F. Their link pins were formerly oiled by hand, but now the work is done by an air-operated lubricator designed especially for the purpose by J. N. Fauver Company, Inc. The unit is tripped by lugs on the chain sprocket wheel, and as a link pin passes it receives a shot of oil from each of two nozzles which can be adjusted three ways to assure accuracy of aim. Compressed air at a minimum pressure of 40 pounds is used. The plant has 142 of the lubricators in service and, with a transfer table traveling at maximum speed, each can oil 192 link pins a minute.



Better COMPRESSED AIR After-Cooling

● Keeping moisture out of compressed air is the best way to prevent troubles and damage to pneumatic equipment. Water, condensing in the air lines, wears out and rusts out the vital parts of compressed air tools as well as freezing up air lines and delaying production. In many industrial uses excess moisture or oil in compressed air is also damaging to other materials or products.

The best way to halt such troubles is to use a NIAGARA Aero AFTER COOLER with your air compressor. By evaporative cooling, using atmospheric air as the cooling medium, it obtains lower temperatures and produces compressed air containing only 1/2 to 3/4 as much moisture as air cooled by conventional methods. At the same time it saves cooling water costs, repays its installation cost quickly. It also provides compressor jacket water at controlled temperatures.

For complete information, write to

NIAGARA BLOWER COMPANY

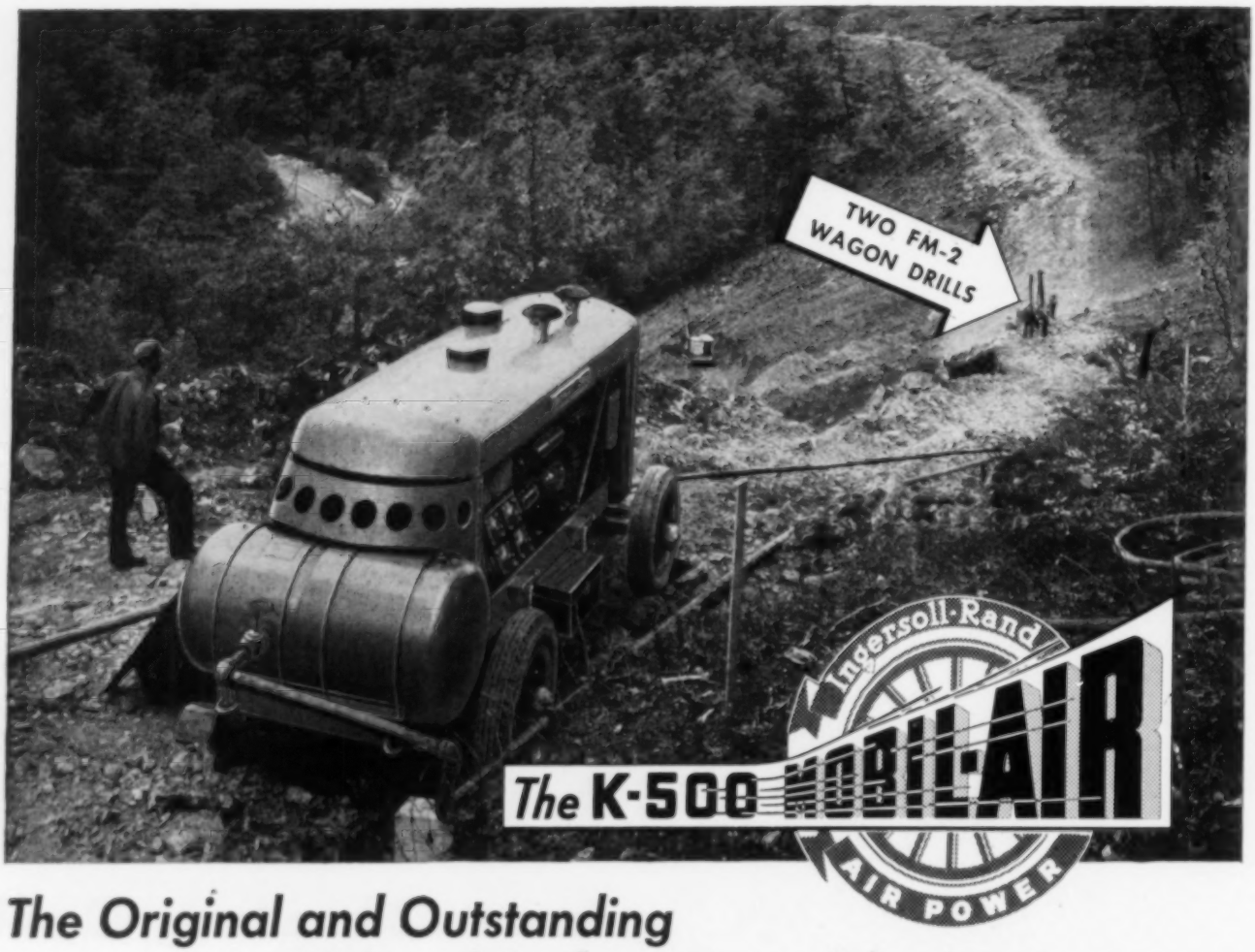
"25 Years of Service in Air Engineering"

NEW YORK Address: Dept. CA-54
6 E. 45th Street,
New York-17, N. Y.

Field Engineering Offices
in Principal Cities

NIAGARA

INDUSTRIAL COOLING • HEATING • DRYING
HUMIDIFYING • AIR ENGINEERING EQUIPMENT



The Original and Outstanding
500 cubic-foot Portable Compressor

And here are some other things you should know about the machine that revolutionized portable compressor practice in 1939:

1 It's the only 500-cfm portable available with a gasoline engine as well as an oil engine. (See ★ below).

2 Weighs only 10,600 pounds... the lightest 500-cfm machine available.

3 Big enough to run two powerful FM-2 wagon drills.

4 Small enough and tough enough to go trail-blazing over mountains and through swamps.

5 Drill-More multi-speed regulator makes the machine even more efficient at half load than at full load. When running only one wagon drill or lighter drills, no more fuel is required than if a smaller compressor were used.

6 Multi-speed regulation of portable-compressor capacity was originated by Ingersoll-Rand... introduced with the K-500. The average working speed of compressor and engine is lower... more efficient ... less wear.. longer life.

7 Spring mounting and automotive-type steering are standard.

8 Electric cranking with commercial 12-volt equipment is standard for oil as well as gasoline engine. Both engines are easily hand-cranked.

9 "Finger-tip" control of heavy-duty, easily maintained clutch.

10 All operating controls and gauges are centrally located.

11 Low, easily filled fuel tank.

12 Proven design, performance, stamina, and reliability... used all over the world.

★**13** Quickly convertible from operation on one fuel to another (oil, gasoline, or natural gas) by substituting external fuel accessories only.

★**14** Astonishingly low gasoline consumption presents a new consideration in the choice between oil and gasoline drive.

★**15** For oil, it's the well-known I-R Type H engine ... smooth running, easy to maintain, easy to start.

11 BROADWAY, **Ingersoll-Rand** NEW YORK 4, N. Y.

2-437

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

For pump drives that must keep going specify ELLIOTT TURBINES

Thousands of these tough mechanical drive turbines are serving Uncle Sam. Thousands more are serving industry, wherever pumps, compressors or similar equipment must be driven dependably. Operating engineers seem to develop a kind of affection for them, because of their virtually unfailing reliability. There are good reasons, all covered in the Turbine Bulletin. Write for it.

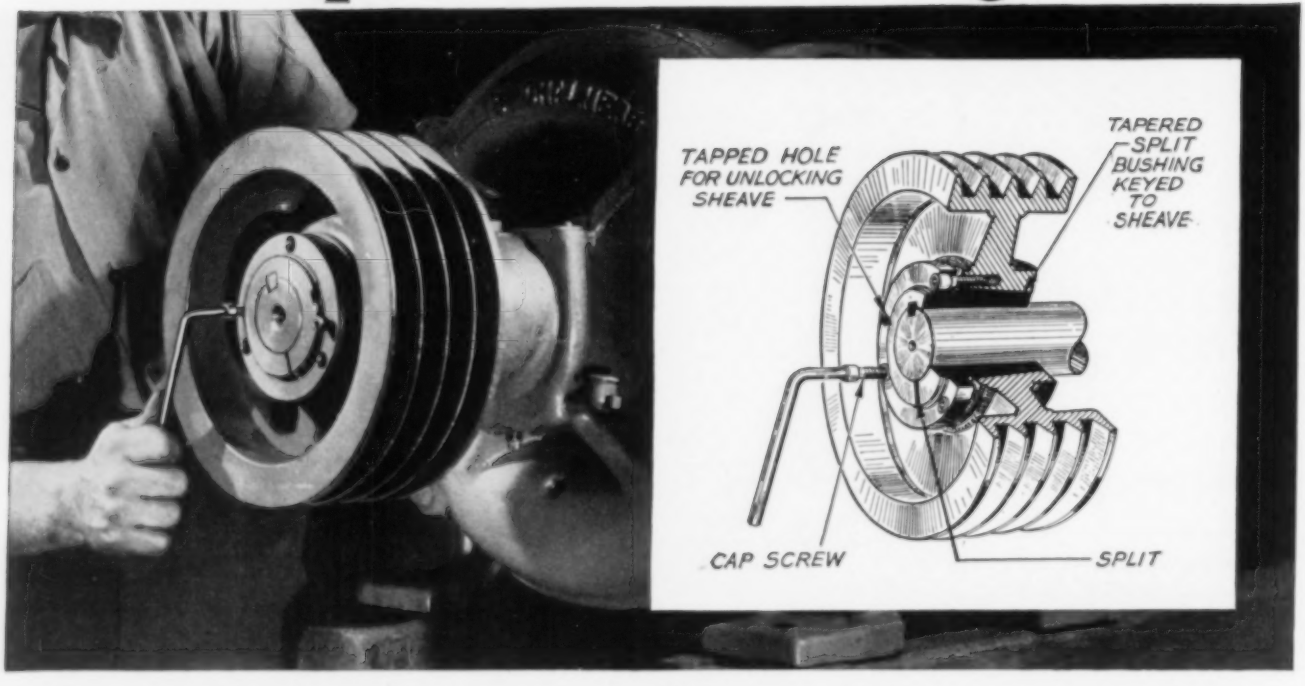
H-678

ELLIOTT COMPANY

Steam Turbine Dept.
JEANNETTE, PA.
District Offices in Principal Cities

STEAM TURBINES • GENERATORS • MOTORS • CONDENSERS
FEEDWATER HEATERS AND DEAERATORS • STEAM JET EJECTORS • CENTRIFUGAL BLOWERS
TURBOCHARGERS FOR DIESEL ENGINES • STRAINERS • TUBE CLEANERS

It's Smoother Running because it "Grips like Magic!"



...And it's the fastest mounting sheave on the market—goes on with one easy locking operation—saving man-hours and money.

POSITIVE clamp fit of Allis-Chalmers' great new "Magic-Grip" sheave means shafts are gripped tightly and uniformly...eliminating wobble and shear!

Its tapered split bushing makes it possible for anyone to mount or remove sheave quickly and easily — an important worker-safety feature. Accommodating normal shaft tolerances, the sheave that "grips like magic" may be changed often without injury to shaft.

And you get the great new "Magic-Grip" sheave... *at no increase in price!* Now, more than ever, it pays to make Allis-Chalmers your "V-Belt Headquarters."

For complete information, ask our nearest district office or Texrope dealer for Bulletin B6310. Or write ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 1681

Allis-Chalmers Texrope "MAGIC-GRIP" SHEAVES

Forty-four Giant Stainless Steel Valve Castings Produced from Lebanon (CIRCLE L) 22

"SIMPLY another lend-lease job," said a Lebanon foundry engineer in speaking of these 16" gate valve castings—among the largest all-stainless valve castings ever made. Big as these castings are, they give only a small indication of Lebanon's product range and of the capabilities of Lebanon (L) 22.

This 18% chrome, 8% nickel alloy satisfactorily resists acetic acid, alkaline liquors, ferrous sulphate, sodium sulphate, hydrogen sulphide, acid mine waters and many other corrosive solutions at normal temperatures.

A few of the many installations to which Lebanon (L) 22 has been successfully applied are: marine scuttle covers; centrifugal separator disc holders; dyeing reel spider and cup rings; valves and valve trim in the chemical and process industries.

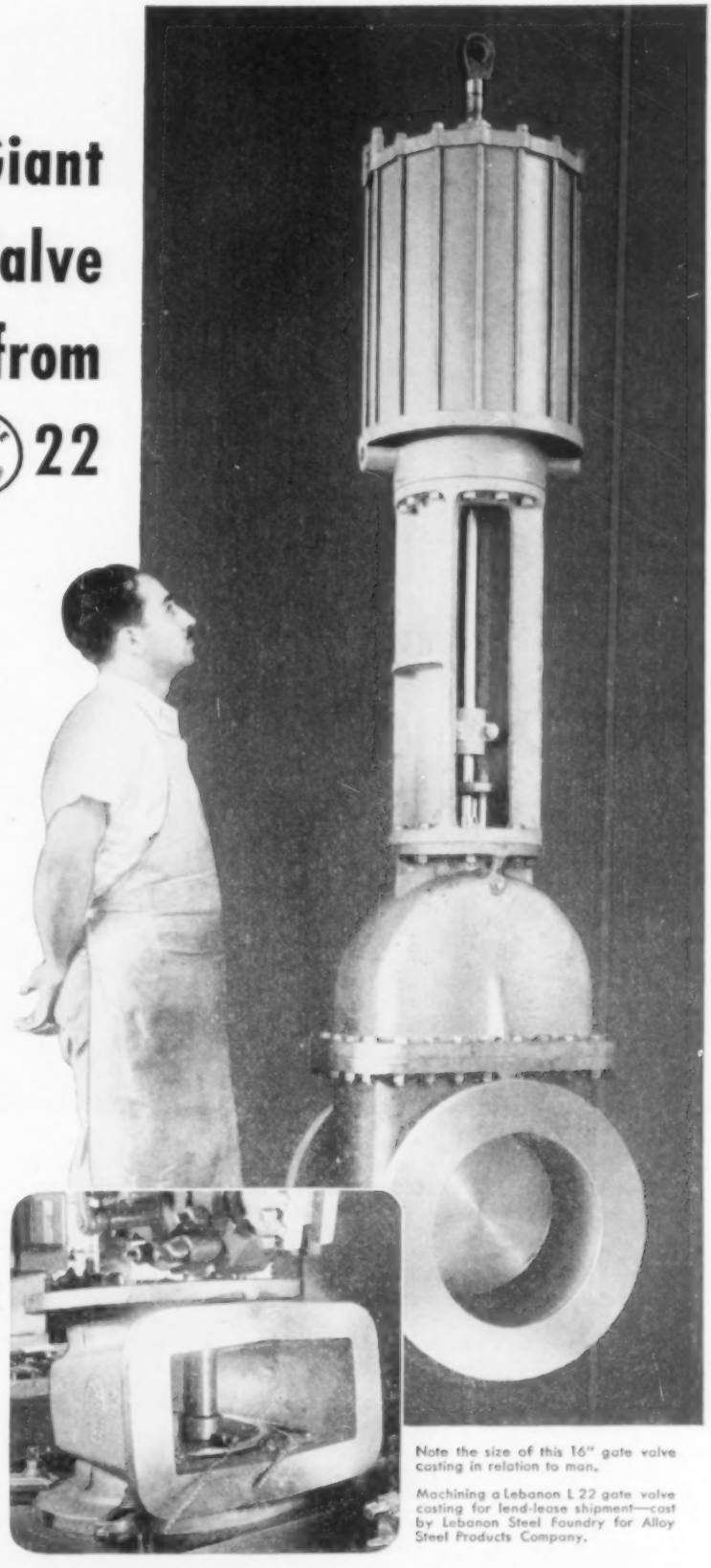
This alloy of wide use may offer a solution to one or more of *your* corrosion problems. Consider it when planning reconversion units—and talk it over now with Lebanon metallurgists and foundry engineers.

Physical Characteristics of Lebanon (L) 22
(Properly Heat Treated)

	Minimum Values
Tensile Strength (lbs. per sq. in.)	70,000
Yield Point (lbs. per sq. in.)	32,000
Proportional Limit	25,000
Elongation in 2"	45%
Reduction of area	50%
Impact Value (Charpy) Room Temp.	75 ft. lbs.
Minus 150° F.	15 ft. lbs.
Brinell Hardness	140 to 175

LEBANON STEEL FOUNDRY

LEBANON PENNA.



Note the size of this 16" gate valve casting in relation to man.

Machining a Lebanon L 22 gate valve casting for lend-lease shipment—cast by Lebanon Steel Foundry for Alloy Steel Products Company.

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

LEBANON (CIRCLE L) *Stainless and Special Alloy* **STEEL CASTINGS**

YES...a WALSEAL* fitting can be removed

Silbraz* joints are the strongest connections that can be made on brass or copper pipe or tubing. In hundreds of installations, **Walseal Valves**, Fittings or Flanges for making Silbraz joints (patented products of the Walworth Company), have proven their ability to withstand severe shock and vibration, resist corrosion and remain tight and leakproof.

But when a Walseal fitting must be removed to make alterations or repairs, it can be easily done. To remove a Walseal flange, for example, heat around the entire hub of the flange, with an oxy-acetylene flame, until the hub turns a dull red color. Direct little or no heat to the pipe or tube. The flange is then given a slight shaking motion by a helper, using hooks. The shaking motion of the heated flange breaks the brazed joint and allows air to enter between the parts, quenching the alloy. The flange may then be removed.

The flange may be re-used in the same or a new position. Enough alloy usually remains in the insert groove to permit a second joint to be made, without the necessity of inserting additional alloy.

For complete information on the installation of Walseal valves, fittings and flanges, send for Bulletin No. 84.

*Registered Trade Marks.

SEND FOR CATALOG

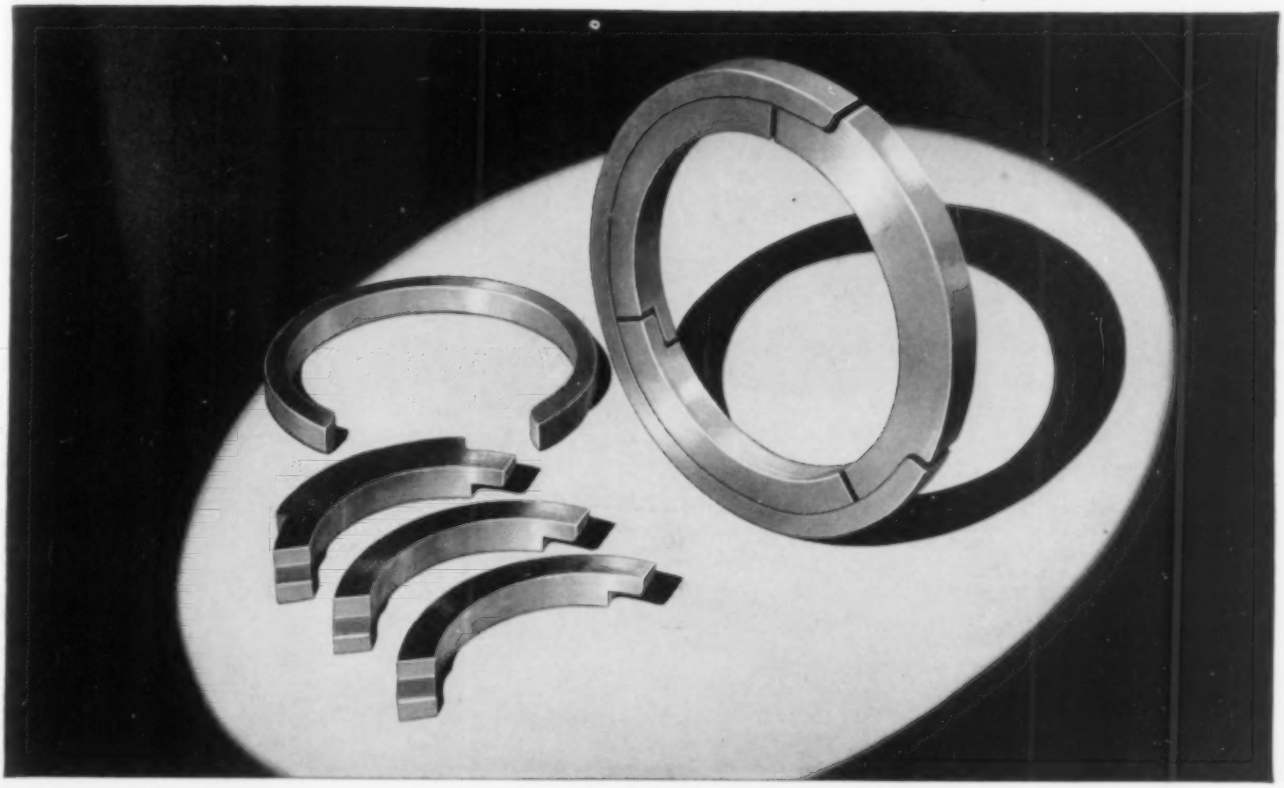
You'll find pertinent information on Walworth's complete line of valves, fittings, pipe, and pipe wrenches in the new Walworth Catalog 42. Included are 78 pages of practical engineering data that simplify valve selection and make piping layouts easier. Write, on business stationery, for your free copy. Address: Walworth Company, 60 E. 42nd St., New York 17, N. Y. Dept. 517.

BOSTON WORKS
KEWANEE WORKS

WALWORTH
valves AND fittings

WALWORTH ★ VALVES AND FITTINGS ★ ESTABLISHED 1842

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



IMPROVED FIRE CHECKS

FOR DOUBLE-ACTING GAS ENGINE PACKINGS

IN a Double-Acting Gas or Diesel Engine packing, special packing rings are required that will withstand the impact of explosion and the intense heat of the burning gases. These rings are called Fire Checks.

COOK has engineered many style Fire Checks—each of unique construction to meet specific operating conditions. Of these Fire Checks, the styles used most widely in the oil and gas industries are Types RG, OG and K. Type OG is illustrated above. It is shown because it is typical of all three and most readily discloses the simplicity of construction. Note there are only four parts. Note the absence of any screws or rivets in the "lug" ring. Note also that the wearing segments have step-seal joints, thus enabling the use of only one ring per groove.

Type K differs from Type OG principally in the joint construction, having butt cut joints and is therefore used in pairs. But in either case the overall number of rings would be the same.

Fire Checks usually are made of COOK'S GRAPHITIC IRON, although Cookmet sometimes is used if a ring made of plastic bronze is indicated, in which case style RG is employed.

COOK'S improved Fire Checks have been time tested in the field before a general offering, as are all of COOK'S products. Today these improved Fire Checks are being used by leading operators in the natural gas industry everywhere.

You, too, will find COOK'S Gas Engine Packings and COOK'S Compressor Packings a good investment. Our nearest office will give you prompt and efficient service. And when ordering new equipment, make sure you get the genuine by specifying COOK'S.

C. LEE COOK MANUFACTURING CO., Incorporated, Louisville, Kentucky. Branches and Representatives: Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, Montreal, New Orleans, New York, Portland, Ore., San Francisco, Seattle, Tulsa.

"Sealing Pressures Since 1888"

COOK'S METALLIC PACKINGS

DELIVERING...

When the Chips are Down

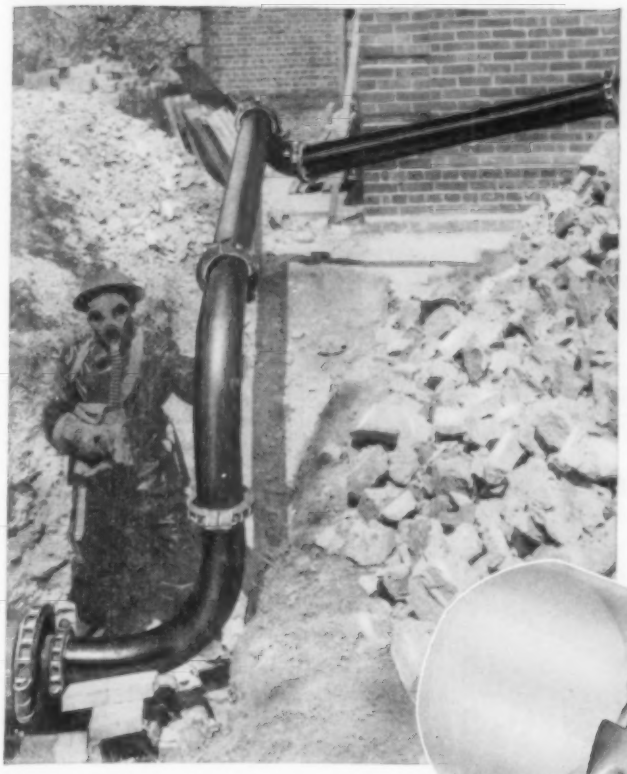
Emergency performance is an old, old story for Bucyrus-Erie excavators. Long a feature of Bucyrus-Erie machines, the ability to deliver record output when it's needed the most proves its value more than ever now. That's why Bucyrus-Eries are such important contributors to the speed-up of wartime operation — why you'll find them on the battlefronts and on the homefront working 24 hours a day to help bring victory nearer. V-49

Plan now to include field-proved Bucyrus-Erie quality and performance in your equipment. Whatever your excavating need, there's a Bucyrus-Erie excavator to fill it — shovels, draglines, cranes, dragshovels, etc. for low cost, high output service.

ARMY E NAVY

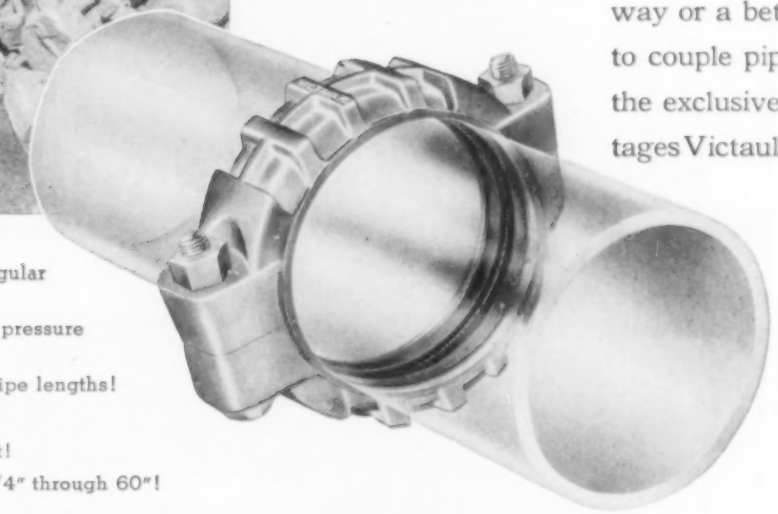
Bucyrus-Erie

SOUTH MILWAUKEE, WISCONSIN, U. S. A.



One good reason why the London "Blitz" Failed...

For just plain "guts" and ability to take it... you couldn't beat the English people. Nor could you beat the method they had for keeping London's life-lines in service. As fast as Hitler could blast their water, gas and sewer lines ... the English would repair 'em and hook them back together again with Victaulic Couplings. Nobody has ever yet discovered a faster way or a better way to couple pipe. Note the exclusive advantages Victaulic offers.



1. Fast Self-Aligning permits angular deflection!
2. Leak-tight, self-sealing under pressure or vacuum!
3. Positive mechanical lock of pipe lengths!
4. Every joint is a pipe union!
5. Every joint an expansion joint!
6. Available for all pipe sizes 3/4" through 60"!

SPECIAL VICTAULIC ADVANTAGES FOR INDUSTRIAL USERS!

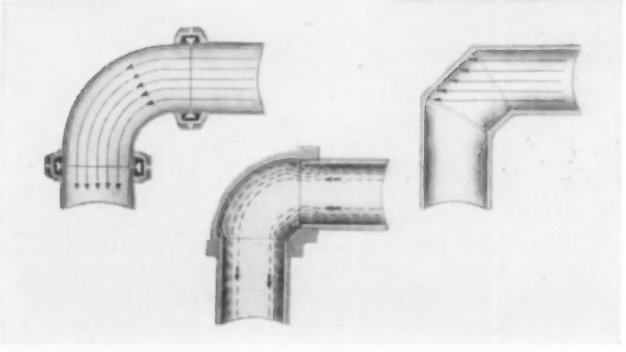
★ **Can be installed faster and with less labor than any other method!**

★ **Lower installation costs... unskilled labor can do the job.**

★ **No expensive equipment needed ... one small wrench is the only tool required.**

★ **Substantial savings in space and weight.**

★ **Temporary lines can be salvaged 100 per cent. Maintenance is nil!**



MORE EFFICIENT FLOW WITH VICTAULIC FULL-FLOW FITTINGS!
Left-hand illustration shows Victaulic's smooth, unrestricted flow. Compare it with the turbulence and restrictions of screwed and mitre-weld fittings also illustrated. Victaulic Full-Flow means increased delivery, lower pumping costs. There's a Victaulic Fitting to meet every piping need.

BUY MORE WAR BONDS!

VICTAULIC

Reg. U. S. Pat. Off.

SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

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NEW VICTAULIC CATALOG MANUAL

...a must for every firm that uses pipe. Contains all you need know about Victaulic Couplings and Full-Flow Fittings. Write to nearest address for your copy today on your firm's letterhead. Victaulic Company of America, 30 Rockefeller Plaza, New York 20, N. Y.; Victaulic Inc., 727 West 7th St., Los Angeles 14, Calif.; Victaulic Co. of Canada, Ltd., 200 Bay Street, Toronto.

SAVE FUEL

with MAXIM HEAT-RECOVERY SILENCERS

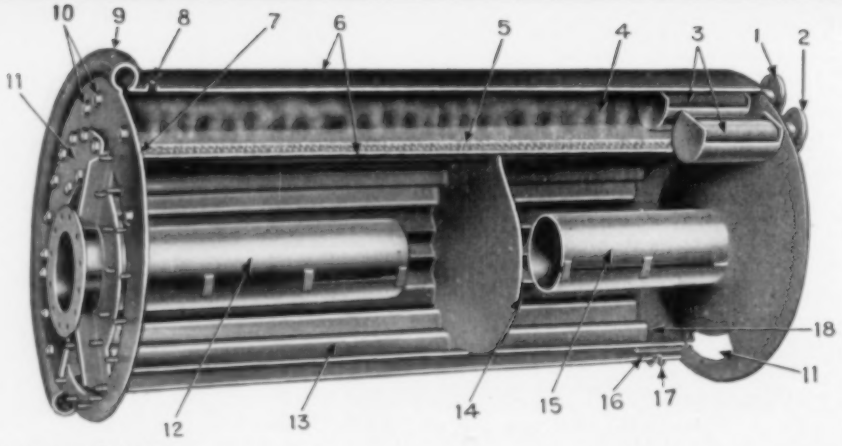
When Maxim Heat Recovery Silencers provide steam or hot water for heating or processing purposes *no extra fuel is used.* The source of heat is simply engine exhaust gases normally wasted. In nearly all cases it is necessary to silence the exhaust outlet and Maxim Heat Recovery Silencers provide this necessary silencing plus the very important saving possible through the production of usable steam or hot water without additional fuel cost.

As a matter of operating efficiency this is obviously good practice at any time, but in wartime the possibility of conserving fuel takes on even greater importance.

Maxim Engineers will be glad to discuss the application of Heat Recovery Silencers to your Specific problem. Descriptive Bulletins WH-100, WH-102 and WH-103 will be sent on request.

• • • •

Maxim Silencers without the heat recovery feature are available for effective silencing of internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request. Please give details.



1—Steam Outlet
2—Safety Valve Connection
3—Dry Pipes
4—Steam Space
5—Water Line
6—Shells—Cylindrical to withstand steam pressure and pulsating gas flow
7—Inlet Head
8—Pressure Gauge Connection
9—Expansion Joint—permits dry operation
10—Water Gauge Connections
11—Cleanouts — provide easy access for cleaning heating surface
12—Inlet Bleeder Tube
13—Extended Heating Surface—forming conduits for leading exhaust gases from one attenuating chamber to the other
14—Insulated Intermediate Head
15—Outlet Bleeder Tube
16—Feed Water Deflector Plate
17—Feed Water Connection
18—Exhaust Gas Outlet from side conduits formed by extended heating surfaces

THE MAXIM SILENCER CO.
85 Homestead Ave., Hartford, Conn.

ARMY E NAVY

MAXIM

Safety

YOU'D SMILE TOO!

For over 25 years Constant Pobol has climbed high on ships drilling holes where needed, and has maintained a perfect no-accident record at the Federal Shipbuilding and Dry Dock Company, Kearny, N. J.

A factor not to be overlooked in this remarkable record is the use of AIR tools. Men and women of industry prefer them because their light weight, small size, and balanced design reduce operator fatigue, thereby minimizing the possibility of accident.

AIR-tool power lines represent the safest method of transmitting power in an industrial plant.

Overloading merely stalls the air motor without a breakdown or a possible injury to the operator.

Unequalled ease and flexibility of control permit the operator to handle AIR tools with greater skill. Starting and stopping are almost instantaneous. Speed and torque can be varied at will.

Nothing is more important than the safety of workers. AIR tools are helping to keep them fit and available for duty in industry everywhere.

Choose from the complete line of Ingersoll-Rand AIR tools.

Ingersoll-Rand

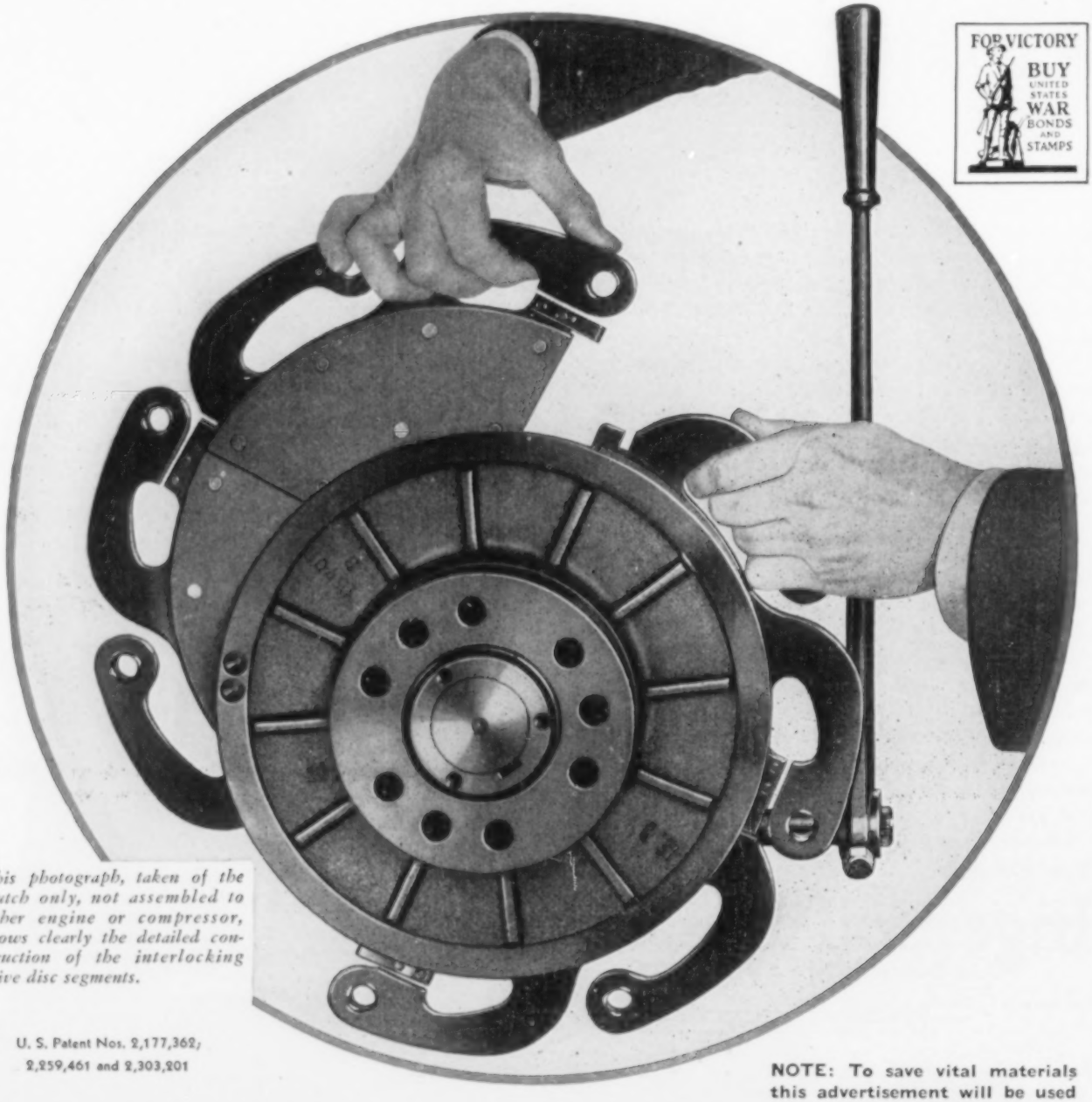
11 Broadway, New York 4, N. Y.

8-355

COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

FLEX-DISC CLUTCHES

Used on the entire line of I-R *Mobil-Air* Compressors, have a time proven drive disc with flexible fingers solidly bolted to the fly wheel. When the friction facings become worn these drive discs, which are quickly detachable in segments, may be removed and relined or replaced without disconnecting the engine from the compressor.



FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

This photograph, taken of the clutch only, not assembled to either engine or compressor, shows clearly the detailed construction of the interlocking drive disc segments.

U. S. Patent Nos. 2,177,362; 2,259,461 and 2,303,201

NOTE: To save vital materials this advertisement will be used for "the duration."

C. M. EASON, INDUSTRIAL CLUTCH CO.

Waukesha Wisconsin

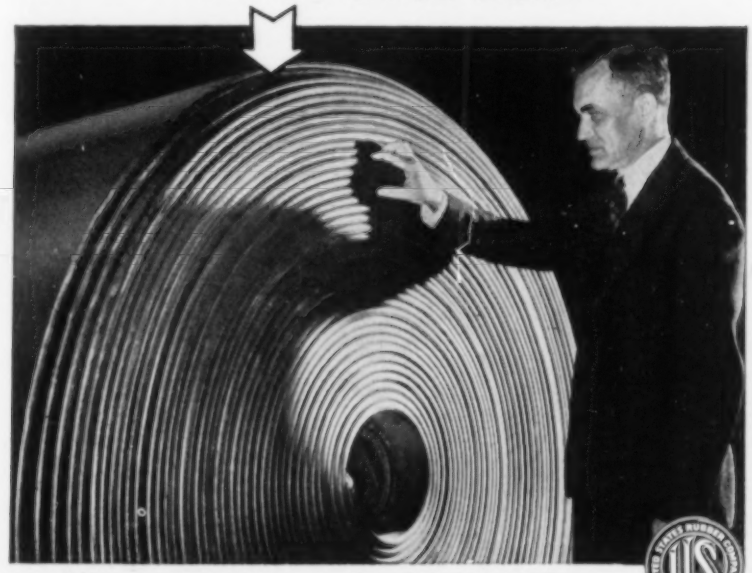
"THIS *is synthetic rubber*"

One is a raw material... the other a finished synthetic rubber conveyor belt, made by United States Rubber Company for tough wartime service. Between the two lies a wealth of applied scientific knowledge, technical skill and compounding experience.

For years we have been making conveyor belts with synthetic rubber for special installations. This was in keeping with our policy to design and build each conveyor belt to meet the specific conditions involved.

Now that synthetic rubber is a "must" for all conveyor belts this policy continues... every U.S. Conveyor Belt is engineered to meet all physical and chemical forces encountered in its individual conveying job—also to have the essential characteristics of flexibility, for proper troughing, and perfect alignment.

"AND *so is this*"



SERVING THROUGH SCIENCE

THEY'RE FLEXIBLE—THEY TROUGH—THEY'RE ALIGNED... Hundreds of thousands of feet of U.S. Rubber Conveyor Belting are helping today to handle ore, coal, limestone and many other types of bulk material used in the manufacture of America's war products.

Listen to the Philharmonic-Symphony program over the CBS network Sunday afternoon, 3:00 to 4:30 E.W.T. Carl Van Doren and a guest star present an interlude of historical significance.

UNITED STATES RUBBER COMPANY

1230 SIXTH AVENUE, ROCKEFELLER CENTER, NEW YORK 20, N. Y. • *In Canada:* DOMINION RUBBER CO., LTD.

IF THE FORGING IS HEAVY DUTY, IT SHOULD BE NATIONAL FORGED

A Forging is born

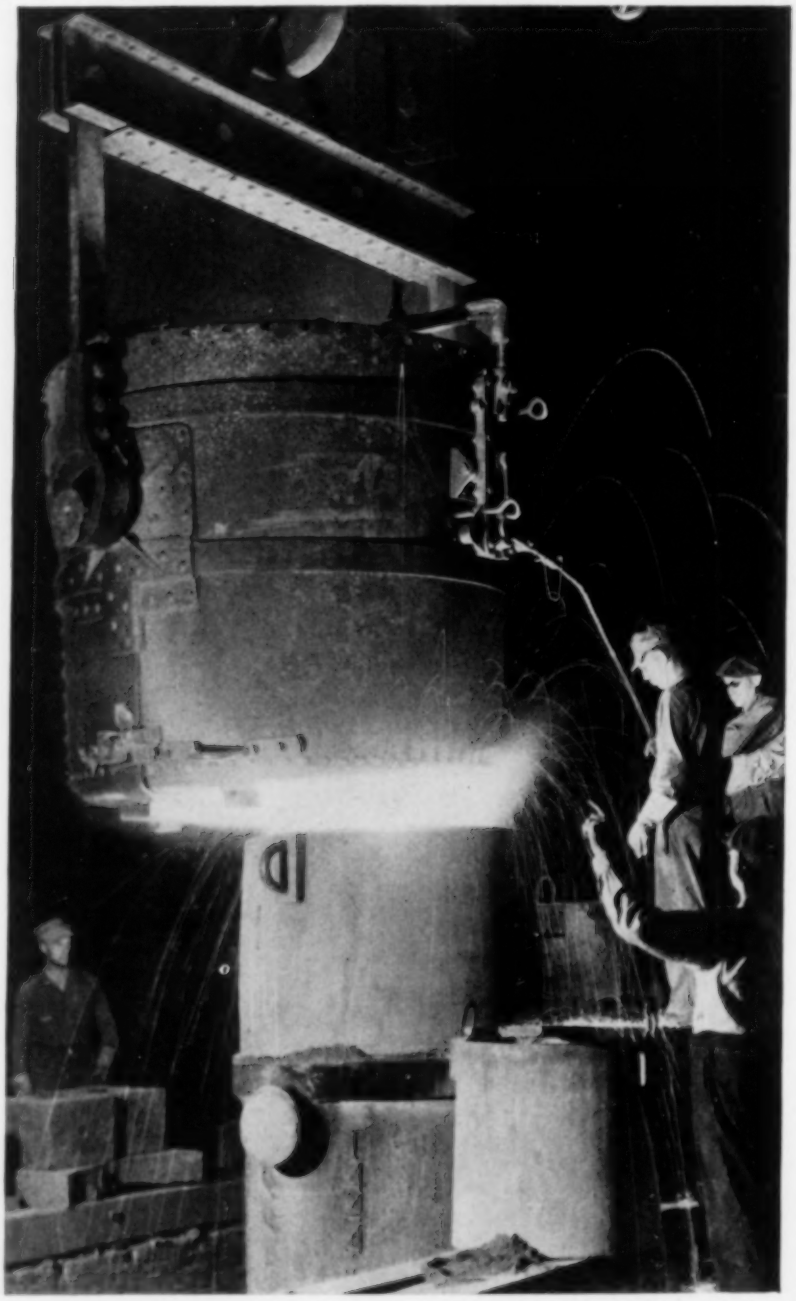
IN A BATH OF STEEL

AND the steel must be right. Not just as fine steel, but as the correct analysis for the work and service the heavy duty steel forging is destined to perform.

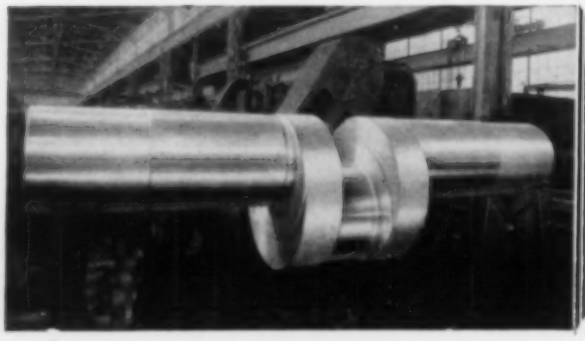
National Forge makes certain of the steel quality in its forgings by making its own steel in Heroult basic electric furnaces —a process that permits the closest metallurgical control. The steel must measure up to requirements and National Forge has an unsurpassed reputation for making "clean steel." The close control and rigorous inspection makes sure that the steel is free from injurious defects. It must meet the analysis and have the correct grain structure required by the purpose of the forging.

Made right, poured right and properly pre-heated, the steel ingot is ready for the expert forgesmithing, heat treating and high precision finish machining operations which are so essential in producing a forging that will deliver long sustained performance.

There is no divided responsibility when National Forge makes a forging and vou always have greater confidence in the forgings that are National Forged.



A forging begins to take shape in the teeming of the ingot—a process simple to picture but highly important in the making of quality forgings.



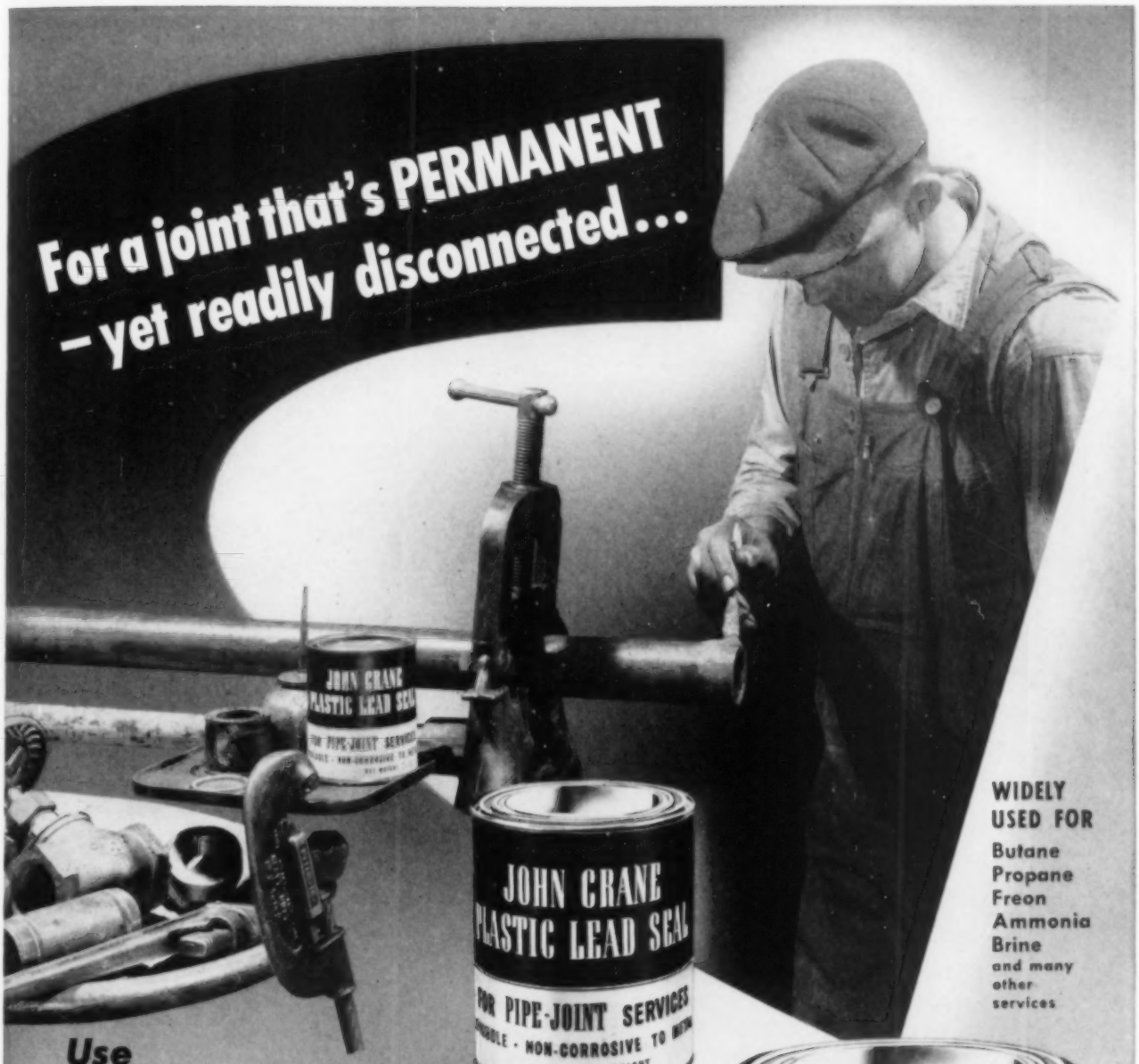
For this extra heavy press crankshaft, an ingot of ample size was required to permit thorough working in the forging press—a National Forge practice which assures forgings of inherent stamina.

NATIONAL FORGE
& ORDNANCE CO.
IRVINE, WARREN COUNTY, PENNA.
"WE MAKE OUR OWN STEEL"

For Excellence E *in Production*

☆ ☆ ☆ ☆

For a joint that's PERMANENT — yet readily disconnected...



WIDELY USED FOR
Butane
Propane
Freon
Ammonia
Brine
and many other services

Use

JOHN CRANE *Insoluble* PLASTIC LEAD SEAL

This multi-purpose pipe-joint compound is insoluble in oil, gasoline, steam, water and many other liquids and gases — hence Plastic Lead Sealed joints are *permanent*. Does not harden or set with age; prevents corrosion — hence old joints are broken as easily as new. Smooth, free-spreading—readily fills all clearances. Remains plastic; unaffected by vibration or temperature changes. Send for test sample (mention service intended) and see for yourself.

Packed 1 and 7 lbs., ready for use.

CRANE PACKING COMPANY

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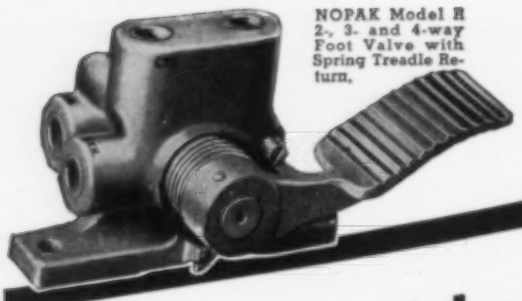
BALTIMORE, BOSTON, BUFFALO, CLEVELAND, DALLAS, DETROIT, HOUSTON, LOS ANGELES, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, SAN FRANCISCO, ST. LOUIS, TULSA

CRANE PACKING CO., LTD., Hamilton, Ontario, Canada.
Branches: Montreal, Toronto, Vancouver



NOPAK Model R 2-, 3- and 4-way Foot Valve with Spring Treadle Return.

NOPAK Foot Valves FREE Both Hands

Foot control of pneumatic or hydraulic machine movements can be vital factors in improving the efficiency, productivity and sales appeal of the machines you build.

An outstanding advantage of foot control valves on many machines is the fact that they leave operators' hands free for other tasks, thereby reducing fatigue and nervous tension.

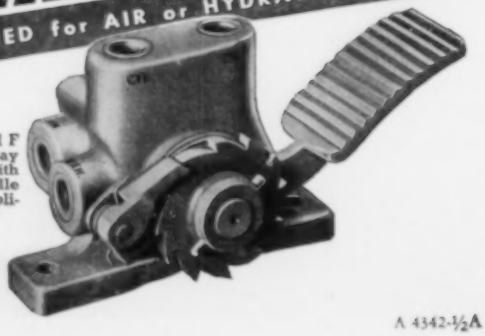
NOPAK 2-, 3- and 4-way Foot Valves are built in Spring Return, Ratchet and Double-Treadle Types. They afford various operating cycles for the control of single and double acting air cylinders or low-pressure hydraulic cylinders employing either oil or water.

For complete Technical Data, write for Bulletin 86.

GALLAND-HENNING MFG. CO.
Milwaukee 7, Wisconsin
2759 S. 31st Street

Representatives in Principal Cities

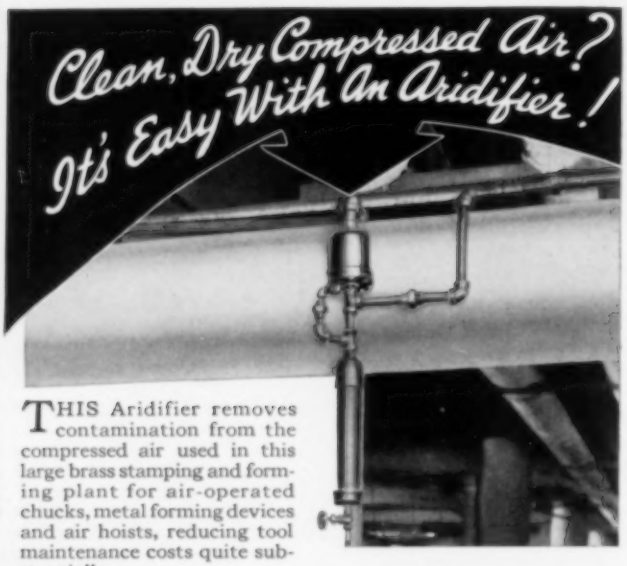
NOPAK VALVES and CYLINDERS
DESIGNED for AIR or HYDRAULIC SERVICE



NOPAK Model F 2-, 3- and 4-way Foot Valve with Ratchet-Treadle for "hold" applications.

A 4342-½A

Clean, Dry Compressed Air? It's Easy With An Aridifier!



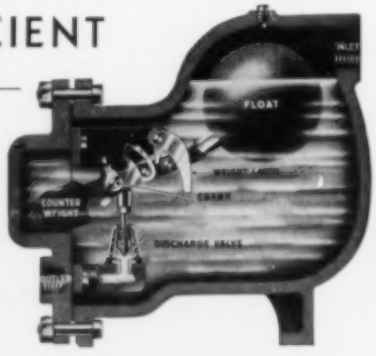
THIS Aridifier removes contamination from the compressed air used in this large brass stamping and forming plant for air-operated chucks, metal forming devices and air hoists, reducing tool maintenance costs quite substantially.

Aridifiers on your air lines are the most positive assurance of clean, dry air and immunity from the damage inflicted on tools and products by moisture, oil and dirt. Correct application of the centrifugal principle assures constant and thorough air cleaning. Write for Bulletin 543.

LOGAN ENGINEERING CO.
4911 Lawrence Ave., Chicago (30), Ill.

The ARIDIFIER
Dries and Cleans Compressed Air

- TROUBLE-FREE
- DEPENDABLE
- EFFICIENT



The NICHOLSON Model "JR"

COMPRESSED AIR TRAP

Has "All 3" Major Virtues

Its wide use under all kinds of working conditions proves its superior effectiveness in draining water and oil from air tanks, receivers, aftercoolers, etc. Large capacity. Pressures to 200 lbs. Bulletin No. 341.

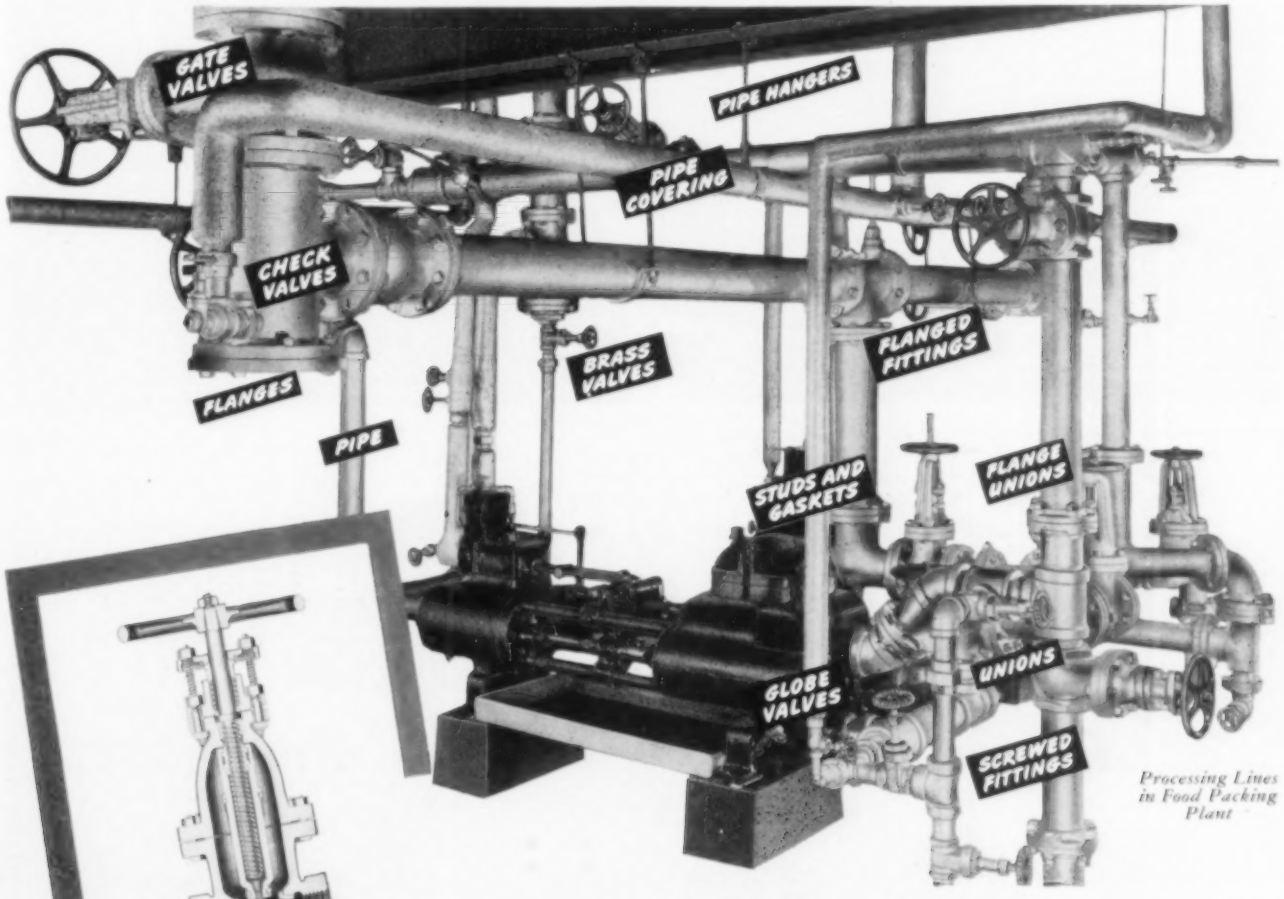
W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties

Anything for piping systems ...Crane can supply it

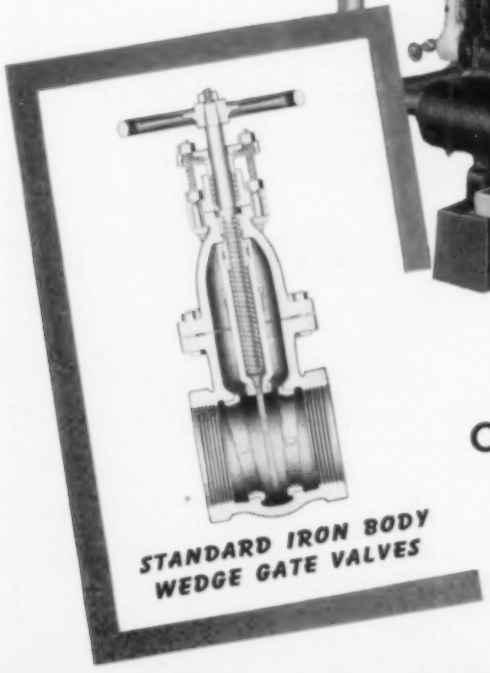
One Source of Supply . . . One Responsibility for All Materials

FROM single pipe fittings to complete piping systems, you stand a better chance of getting just what you need from Crane. For, at Crane you choose from the world's largest selection of brass, iron, and steel materials for every piping service.

In the installation below, for example, every item, pipe, valves, fittings, even studs, gaskets and insulation, are from Crane. Consider the advantages of this single source of supply—how it saves ordering time, simplifies maintenance and keeping of parts stocks. Consider the protection afforded by undivided responsibility for all materials—especially when that responsibility is backed by Crane Co.'s 89-year leadership in the piping field. Are you getting these benefits now? CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill.



Processing Lines in Food Packing Plant



One standard of quality

The whole system is more dependable because of the adequate standard of quality in every part. Look at Crane Quality through Crane Iron Gate Valves. Stronger body design resists line strains. Port openings are straight through, giving streamline flow. A deeper stuffing box lengthens packing life. Adequate power in the stem gives positive seating, while extra long guides keep disc travel true.

CRANE

VALVES · FITTINGS · PIPE
PLUMBING · HEATING · PUMPS

CONDOR V-BELTS

Now made with FLEXLASTICS*

FLEXLASTICS—elastic materials used in combination with Strength Members make CONDOR V-BELTS with highest degree of flexibility, efficiency and lasting service.*

CORD

Strands of strong, pre-stretched cords made to MANHATTAN specifications.

COMPRESSION SECTION

...tough, firm FLEXLASTICS compression section, furnishes sidewall contact. FLEXLASTICS in body resists fatigue, reduces internal friction. Body is wrapped with closely woven fabric to resist wear, yet permit easy flexing.

WHIPCORD SECTION

...backbone of CONDOR V-BELTS...carries the load. Imbedded in strong, tenacious, heat-dissipating FLEXLASTICS to produce a homogeneous, inseparable unit with maximum strength, flexibility, durability and extreme lack of stretch.

8 POINTS of BALANCE

1. Wide margin of strength
2. Minimum inelastic stretch
3. Uniform flexibility
4. Maximum resistance to structural breakdown
5. Smooth running
6. Maximum traction
7. High resistance to side wear
8. Correct lateral reinforcement

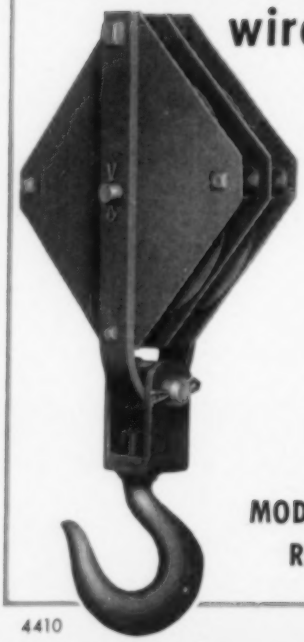
**The term FLEXLASTICS is an exclusive MANHATTAN trade mark. Only MANHATTAN can make FLEXLASTICS.*

KEEP AHEAD WITH MANHATTAN **51st YEAR**

THE MANHATTAN RUBBER MFG. DIVISION
OF RAYBESTOS-MANHATTAN, INC.
Executive Offices Passaic, New Jersey

AMERICAN

wire rope blocks



Standard Duty

For average work which includes most of the service in industry and construction.

Heavy Duty

For extremely heavy construction and erection work.

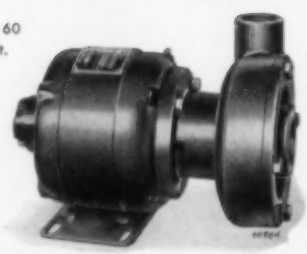
MODERN DESIGN
RUGGED CONSTRUCTION

4410

AMERICAN HOIST & DERRICK CO.
SAINT PAUL 1, MINNESOTA
CHICAGO SAN FRANCISCO NEW YORK

easy to put on and safe

Horizontal type, 5 to 60 gmp Heads to 25 ft.



COOLANT PUMPS *help build tanks and planes*

Immersion type, 5 to 150 gpm Heads to 125 ft.

Sidewall type without seal, 5 to 50 gpm Heads to 19 ft.

Sidewall type with seal, 5 to 60 gpm Heads to 25 ft.

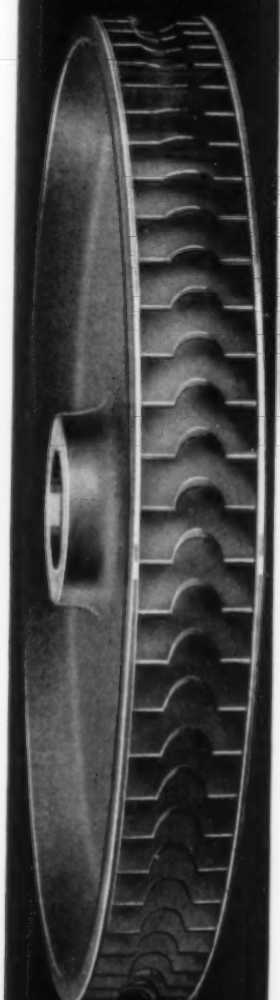
Coolant Pumps are vital in building tanks, planes and guns—are a necessity in the building of any machine. The weight of coolant pumped during machining operations is usually far greater than the weight of the finished machine.

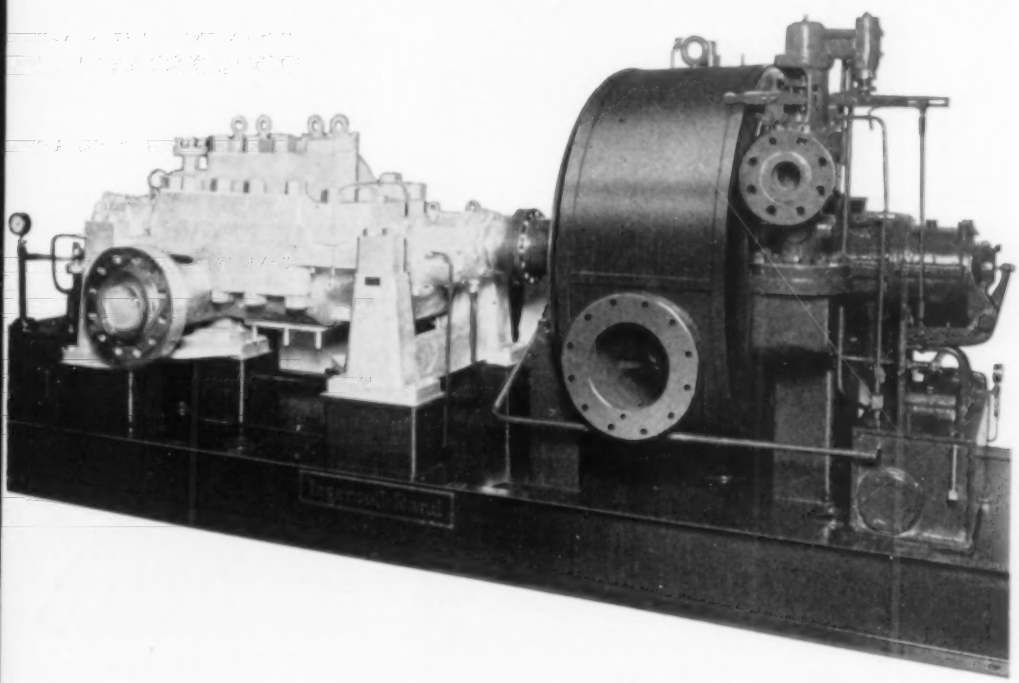
Since dependability of operation is absolutely essential, Ingersoll-Rand coolant pumps are built to stay on the job. They are simple and rugged, requiring a minimum of maintenance. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N.Y.

Ingersoll-Rand

9-379

TERRY





THE ROTOR OF THIS BOILER FEED TURBINE IS DOUBLE RIM PROTECTED!

The 1250 H. P. Turbine shown above employs the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly in the wheel.

The buckets are protected by rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the clearance became reduced.

With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

The Terry Wheel Turbine is fully described in our Bulletin S-116.

T-1152

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

EXACTNESS RULES HIS WORK

How exacting he must be is dictated to him by a sheet of blue paper—a blueprint. There can't be any guess work here. Every detail—every dimension—every view must be shown in complete clarity. For on his ability to interpret the blueprint rests victory or defeat.

To take the "guesswork" out of blueprints, draftsmen . . . engineers . . . technicians . . . insist on working with

KOH-I-NOOR

because **KOH-I-NOOR Drawing PENCILS** can be depended on for sharp . . . crisp lines which produce sharp, clean prints...

because **KOH-I-NOOR Drawing PENCILS** can be depended on for the same fine quality that has made them standard for more than 50 years.

Available in 17 uniform degrees of hardness and softness.

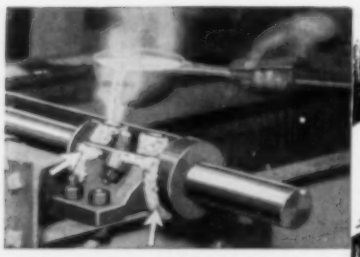
ECONOMICAL IN THE LONG RUN!

NO. 1700 – TECHNICRAYON PENCILS
Made in 40 brilliant colors. Each pencil is polished in the color of the lead . . . for easy identity. Available in sets only of 12 or 24.

Send for Leaflet No. 19

KOH-I-NOOR

The RIGHT pencil for the RIGHT job
KOH-I-NOOR PENCIL COMPANY, INC., BLOOMSBURY, NEW JERSEY



NO BLOWOUTS!

Babbitrite Prevents Injury From Molten Metal

- Babbitrite contains no moisture, does not generate steam when in contact with hot molten metal.
- Babbitrite's strength of body gives it greater capacity to hold a charge of hot molten metal.
- Babbitrite adheres tightly to the mold or metal, under all working conditions.
- Babbitrite does not melt and allow Babbitt metal to run out, regardless of pouring temperature.
- Babbitrite does not dry out or harden, yet remains moisture-free.
- Babbitrite is ready-for-use, requires no mixing, may be re-used over 100 times.

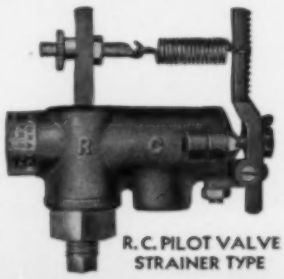
Write for Liberal Sample.

Babbitrite
THE BABBITT RETAINER

PRODUCTS MFG. CO.
517 E. BUFFALO STREET
MILWAUKEE 2, WIS.
A 4265-¼A

R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.

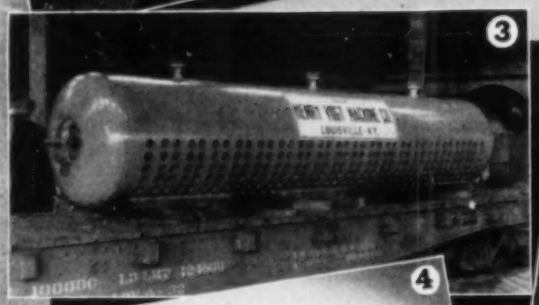


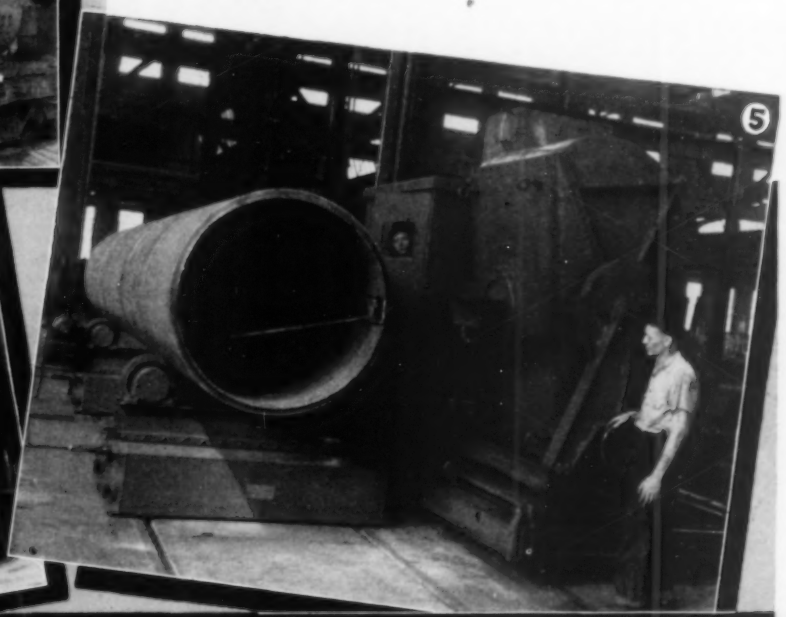
R. C. PILOT VALVE
STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

A.P.I.—A.S.M.E. and A.S.M.E. CODES • CARBON STEEL AND SPECIAL STEEL

WELDED PRODUCTS *by* Vogt





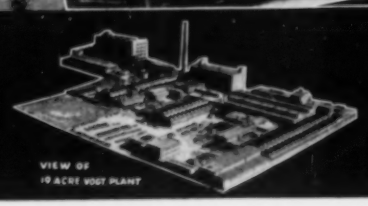
1 - 4′—0″ dia. x 7′—6″ dia. x 82′—5″ high Stabilizer Tower for a Texas Refinery. Fabricated to A.P.I.-A.S.M.E. Code, stress relieved and X-rayed. 250# working pressure.

2 - Heat Exchangers, for an Eastern Refinery, on the testing floor. Units have fusion welded Monel Metal shells and were built to customer's specifications.

3 - 48″ dia. x 22′—6″ long mud drum for a Vogt Water Tube Boiler designed to operate at 450# S.W.P. Fusion welded to A.S.M.E. Boiler Code.

4 - Battery of Absorption Columns in a Western Refinery. Units are 33″ dia. x 41′—0″ high and were stress relieved after welding.

5 - 400 KV Industrial X-ray unit in our plate welding department. Exographs of welded seams can be quickly made because of the special motor operated rolls and traveling carriages which are adjustable to vessels of any size.

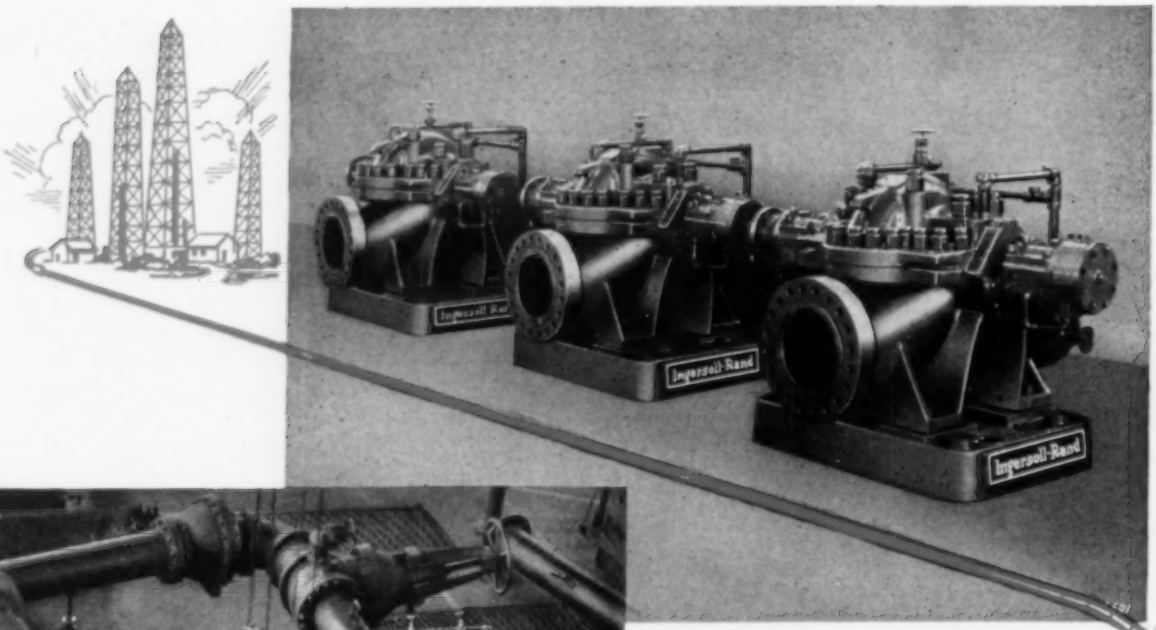

VIEW OF 10 ACRE VOGT PLANT

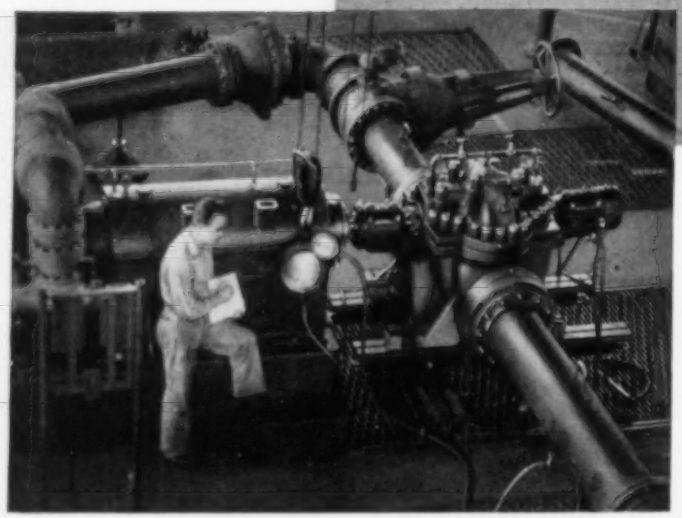
HENRY VOGT MACHINE CO.

Incorporated

LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK · PHILADELPHIA · CLEVELAND · CHICAGO · DALLAS





(Above) There are three pumps operating in series in each station against a total head of 800 psi. These pumps which were designed especially for this line are single-stage, double-suction, and direct-connected to 3750 rpm motors.

(Left) One of the pumps on test.

INGERSOLL-RAND PUMPS ALSO SERVE

THE "LITTLE-INCH" PRODUCTS LINE

It takes millions of gallons of gasoline and oil to win a war. The 20-inch War Emergency Products Line will deliver every day nearly 10,000,000 gallons of gasoline and fuel oil to points where it is most needed. Forty-one Ingersoll-Rand pipe-line pumps, each driven by a 1500 hp electric motor, will be installed on this new line.

These pumps are similar in design to the thirty-six larger Ingersoll-Rand pipe-line pumps now serving the "Big-Inch" Crude Oil Line.

There is much more to the story... I-R engine-driven compressors help to get petroleum from the earth... I-R pumps are used in hundreds of refineries... I-R pumps are used in most of the tankers...I-R portable compressors and tools help to lay the pipe lines... and I-R products serve in many other phases of the petroleum industry. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N. Y.

Ingersoll-Rand

10-452

HOW DAYTON V-BELT DISTRIBUTORS PUT NEW POWER IN OLD DRIVES!

The Problem—

This war plant gear-cutting machine (cutting a 22" gear automatically) was formerly driven by a chain belt which was subject to frequent breakage and consequent loss of critical production time.

The Remedy—

The Dayton Distributor studied the drive and recommended equipping with 6 Dayton V-Belts on an 8-1/2" Drive and 16" Driven Pulley -- 22" center to center.

The Results—

Machine now operates 24 hours a day, every day of the year. No breakage, no slippage, no wasted power, no loss of production time. Greatly increased production.

Any Plant Can Profit From This Free, Expert V-Belt Service!

If you have a drive that is troublesome, inefficient, power-wasting or noisy—call in your local factory-trained Dayton V-Belt Distributor to study it. He will show you how it can be quickly converted to smooth-running, hard-gripping, long-lasting Dayton V-Belts—for fractional to a thousand horsepower.

Remember, the name Dayton Rubber stands for Technical Excellence in natural and synthetic rubber development. You can rely on Dayton V-Belts for the utmost in performance—and on Dayton V-Belt Distributors for the utmost in prompt, expert service.

CALL YOUR DAYTON V-BELT DISTRIBUTOR OR WRITE DIRECT

THE DAYTON RUBBER MFG. CO., DAYTON 1, OHIO

The World's Largest Manufacturer of V-Belts

Dayton Rubber Export Corp., 38 Pearl St., New York, N.Y., U.S.A.

★ LET'S ALL BACK THE ATTACK WITH WAR BONDS ★

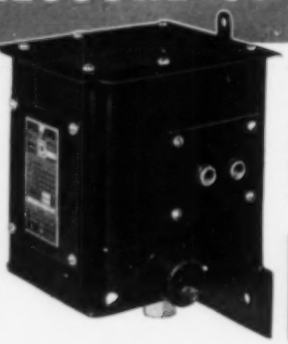
V-Belts by Dayton Rubber

REG. TRADE MARK THE DAYTON RUBBER MFG. CO.

The Mark of Technical Excellence in Synthetic Rubber

Marine PRESSURE SWITCHES

DRIPPROOF AND WATERTIGHT HIGH SHOCK CONTACT BLOCK—TWO OR THREE POLE—CLASS 9013 TYPE AW-H, MW-H, LW-H



ELECTRICAL RATINGS

Voltage	Single Phase A.C.	Polyphase A.C.	D.C.
110V.	2 H.P.	3 H.P.	1 H.P.
220V.	3 H.P.	5 H.P.	1 H.P.
440-550	5 H.P.	5 H.P.	.....
32V.	.....	.....	½ H.P.

• Built for Marine Service to conform with requirements for dripproof and watertight devices of shockproof construction. The switches differ from standard in the use of a special sheet steel enclosure and drip hood with gasket seal and a special high shock bakelite contact block in two or three pole form. The three types AW-H, MW-H and LW-H represent three diaphragm sizes and three range and differential variations. A release valve for air compressor service may be added to any of the types, as illustrated. Write for Bulletin 562.

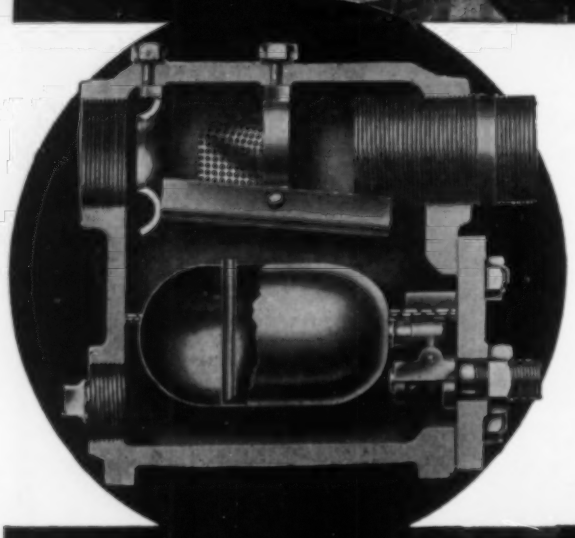
REGULATOR DIVISION

SQUARE D COMPANY

DETROIT • MICHIGAN

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DriAir

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

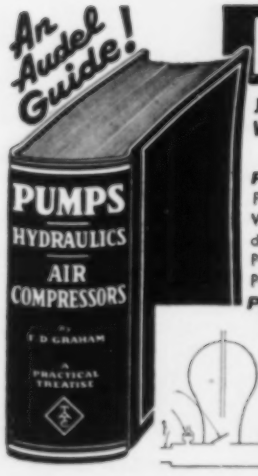
A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY



PUMPS-HYDRAULICS-AIR COMPRESSORS

JUST OUT! 3 BOOKS IN ONE—OVER 1650 PAGES, 1654 ILLUSTRATIONS, WITH QUESTIONS AND ANSWERS. COMPLETE PRACTICAL CONCISE INFORMATION FOR ALL ENGINEERS AND OPERATORS.

***PART 1*—PUMPS—850 Pages:** All types—Centrifugal—Rotary—Reciprocating Pumps: Their Theory, Construction, Operation and Calculations. Air and Vacuum Chambers—Power Pumps—Air Pumps—Jet Condensers—Surface Condensers—Condenser Auxiliaries—Condenser Operation—Calculations—Cooling Ponds—Cooling Towers—Water Supply—Hydraulic Rams—Special Service Pumps—Automotive Fire Pumps—Dredges—Codes. 942 Illustrations.

***PART 2*—HYDRAULICS—320 Pages:** Hydraulic Physics—Drives—Machine Control—Accumulators—Elevators—Hydraulic Airplane Control—Automobile Brakes—Shock Absorbers—Presses—Turbines. Many new uses explained. 310 Illustrations.

***PART 3*—AIR COMPRESSORS—406 Pages:** Compression of Air—Compressor Classification—Parts, Types—Inter and After Coolers—Regulating Devices—Installation—Lubrication—Operation—Maintenance—Blowers—Super-Chargers—Pneumatic Hand Tools—Ready Reference Index and Tables. 402 Illustrations.

Free Examination

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$4 COMPLETE PAY ONLY $1 A MO.

AUDEL, Publishers, 49 West 23 St., New York 10, N.Y.
Send postpaid AUDELS PUMPS, HYDRAULICS, AIR COMPRESSORS ($4). If I decide to keep it, I will send you $1 within 7 days; then remit $1 monthly until purchase price of $4 is paid. Otherwise, I will return it promptly.

Name.....

Address.....

Occupation.....

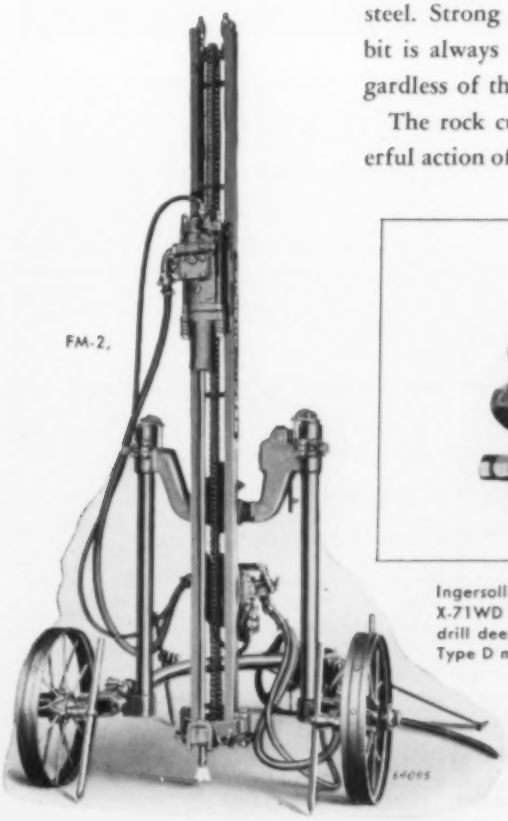
Employed by..... CAM

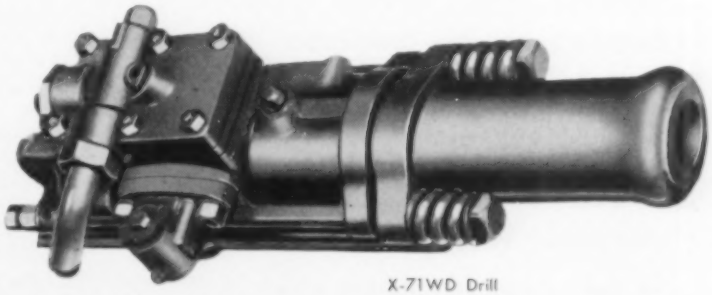
The X-71WD drill is designed especially for deep-hole drilling. Its heavy piston, the heaviest used in any hammer drill, has an extremely long stroke and hits the drill steel a solid, powerful blow.

Added to this slugging power is a unique follow-through characteristic which overcomes the inertia of heavy drill steel. Strong rotation results; hence the bit is always taking deep, fresh bites regardless of the hardness of the rock.

The rock cuttings created by the powerful action of the drill are easily removed by a new method of blowing which greatly reduces the loss of air around the drill steel shank. As a result, the high pressure so necessary for cleaning deep holes is maintained.

These operating features, plus the ruggedness and stamina which are essential qualities of a champion, will help you drill more feet of hole day in and day out. The use of Jackbits in conjunction with the drilling power of the X-71WD will give you even better results. Jackbits are available in sizes ranging from 1⅜ to 4½ inches.





X-71WD Drill

Ingersoll-Rand has developed two wagon mountings to provide portability for the powerful X-71WD Drill. The FM-2, shown at the left, is an extremely flexible 3-wheeled mounting. It will drill deep holes at any angle and will handle six-foot steel changes. Then there is the improved Type D mounting which is used for 10 or 15-foot steel changes, and for holes to a depth of 40 feet.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

5-380

COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

INGERSOLL - RAND "Power Houses on Wheels" USE TIMKEN BEARINGS

Ingersoll-Rand Portable Air Compressors equipped with Timken Bearings supplying power to Ingersoll-Rand Wagon Drills—also Timken Bearing Equipped.

Ingersoll-Rand Portable Air Compressors are equipped with Timken Tapered Roller Bearings on the compressor crank shafts and also in the road wheels; this helps to get them to the job quicker and to keep them on the job longer.

A Timken Bearing Equipped compressor is the ideal anti-frictionized compressor because Timken Bearings provide anti-friction advantages *in full;* these advantages comprise elimination of friction; protection against radial, thrust and combined loads; maintenance of moving parts in correct and constant alignment. They assure constant operating smoothness; greater endurance and longer compressor life. Make sure you have them in your new compressors — portable or stationary. The Timken Roller Bearing Company, Canton 6, Ohio.

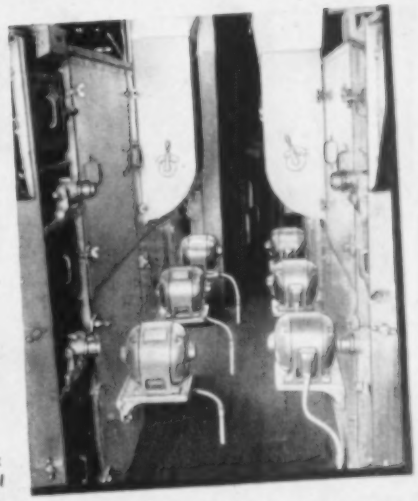
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

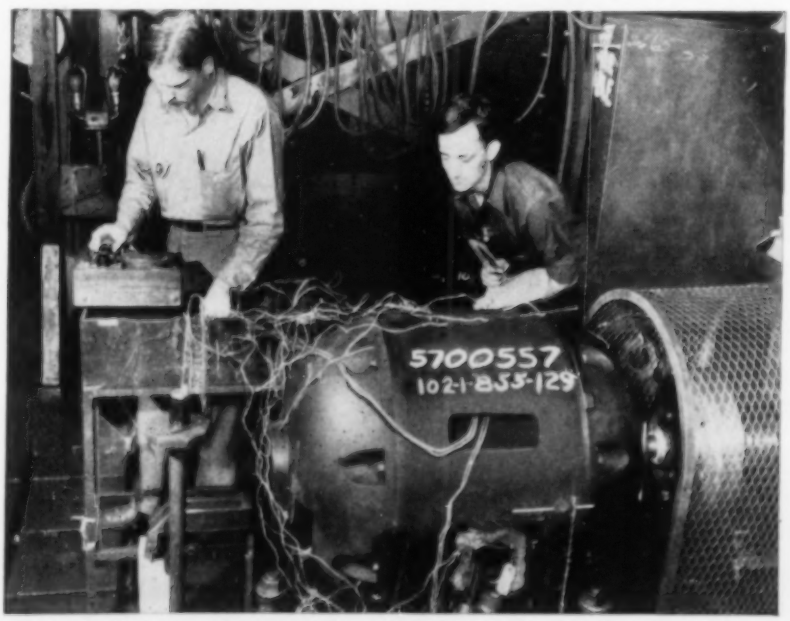
WHEN THE HEAT'S ON

Motor-driven machinery is often called upon to operate under conditions of extreme heat and humidity. For example, the motors on this wool-plant washer must operate in an air temperature of 100° F., with humidity higher than 80 per cent. Conditions like this would shorten the life of any motor lacking effective, performance-tested ventilation design. The double-end cooling system of the Tri-Clad motor helps offset the effects of high ambient temperatures common to heaters, dryers, and many ventilating-fan applications. In addition, motor windings of Formex wire (Class A insulation) are unusually long-lived under total temperatures (ambient plus rise) up to 194 F. For even higher temperatures, Class B insulation offers still greater protection.



G-E Tri-Clad motors applied to Sargent back washers at plant of the Southwell Wool Combing Company, No. Chelmsford, Mass.

Multi-Point Tests on TRI/CLAD Motors Tell Temperature Conditions Inside and Out



Dozens of thermo-couples and thermometers at all vital points of this Tri-Clad motor reveal temperatures under a wide range of load conditions. First, tests like this helped to perfect the double-end ventilation design. Now regular tests of Tri-Clad motors taken off the production line verify previously established temperature-rise limits, and ability of insulation to stand up. Continued research along the same lines, including operation in enclosures which restrict air flow, points the way to further improvements in the future. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

TRI/CLAD MOTORS

Every week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds.

what the clipper's secret means to you-

The Clipper's secret was proper control of air. Schrader equipment and controls give compressed air *power* versatility in industry that urges you to look at air *power* in a new light.

New economy, for example. Schrader Air Ejection Sets apply the principle of controlled, intermittent blasts instead of wasteful constant flow. This saves you air and money.

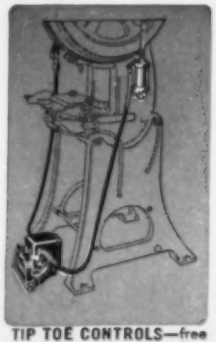
New utility. Even the most skeptical production men are amazed at the number and scope of jobs performed with air *power*. Drilling, boring, tapping, pressing, feeding, ejecting, and countless other operations are made easier with less fatigue, using Schrader compressed air equipment.

Look into the advantages of the Schrader complete line for new economy, new utility, new safety features and relief from operator fatigue.

Write for 48 page catalog No. 10. Schrader devices are available through your distributor. If a Schrader engineer is required for large installations or particularly complicated jobs he, too, is available by arrangement through your distributor.

Power Press and Kick Press Controls Complete, eliminate operator fatigue and incorporate safety features. Also Air System Accessories (check valves, rotating joints, speed control valves, air strainers, 4-way valves and cylinders), Hydraulic Gauges, Air Hose, Hose Ferrules and Tools.

MADE BY THE MAKERS OF SCHRADER TIRE VALVES AND GAUGES



TIP TOE CONTROLS—free hands for guiding or feeding work. Eliminates foot fatigue.

HOSE REELS—air handy where you want it—hose out-of-way when not needed.

QUICK-ACTING AIR COUPLERS—with "safety twist"

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CONTROLS THE AIR
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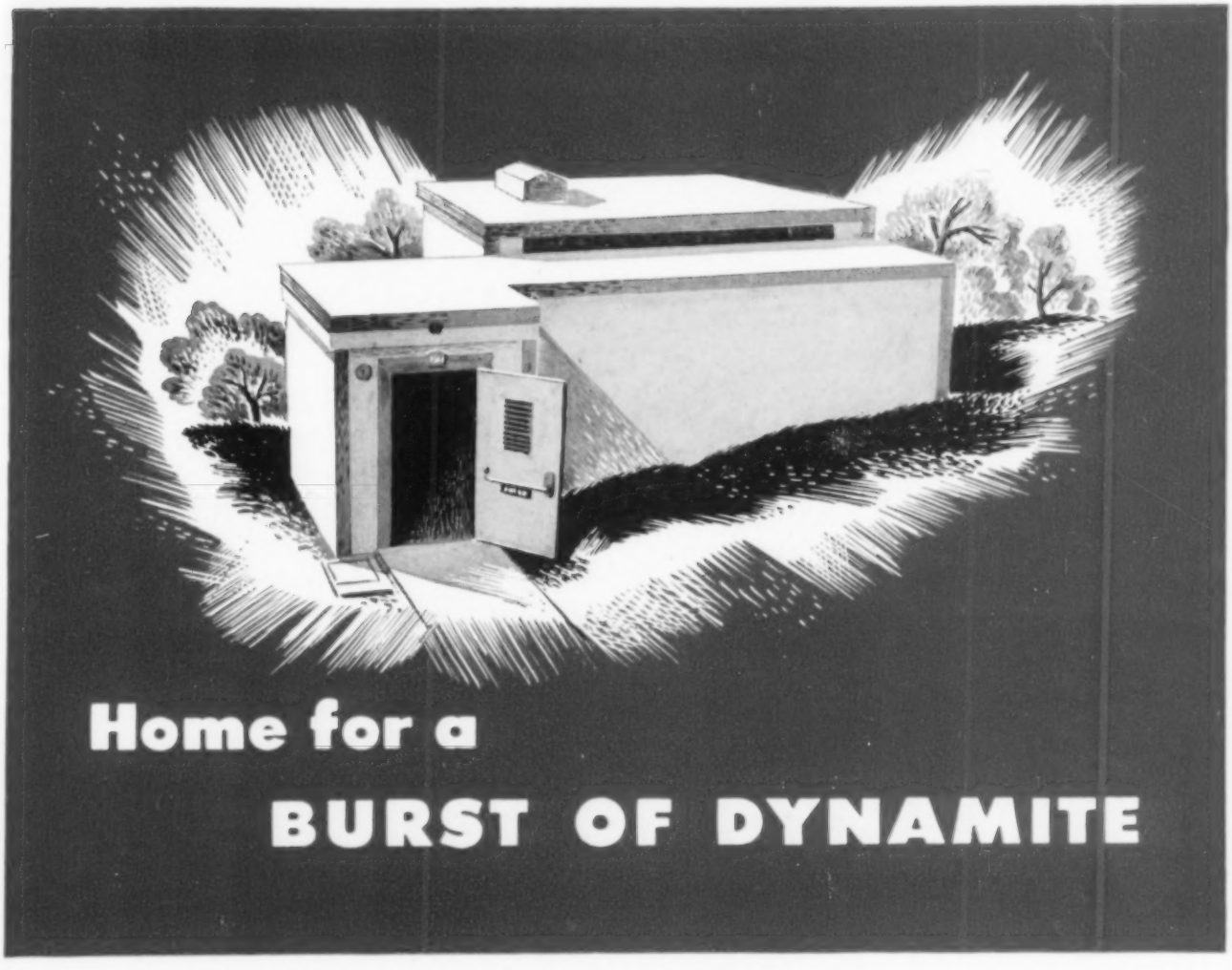
A. SCHRADER'S SON, *Division of Scovill Manufacturing Company, Incorporated,* **BROOKLYN, NEW YORK**



Home for a BURST OF DYNAMITE

THIS BOMB-PROOF SHELTER is radically different from those on the war front. Here the "bombs" explode inside—set off by a remote control electric firing panel. A part of the hook-up is oscillographic equipment which permits the recording of firing times of various types of explosives.

Such experimental work, combined with field experience, contributes to the tremendous fund of knowledge which Hercules has accumulated over the years and is constantly enlarging for the benefit of the users of Hercules explosives everywhere.

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How to Make Each of 328 Fastenings Carry an Equal Share of the Load

Each wing of a DC-3 transport plane is fastened on with 328 nuts and bolts.

Unless the stress and strain are distributed equally, some of the bolts shear off.

The answer was found in Elastic Stop Nuts. These nuts can be given precisely the right tension —then lock fast.

This is one of the important structural fastening jobs which Elastic Stop Nuts have solved.

We've been told Elastic Stop Nuts, by solving many such structural fastening problems, have revolutionized aircraft construction.

These nuts lock fast—are safe. They stay tight and secure even in the face of unusual vibration. That's why they are approved for fastening such vital parts of an airplane's structure.

It's the elastic collar that does the trick. It molds itself to the bolt threads and grips them tight. The nut can't jiggle loose.

After the war ESNA nuts with the red collar will be ready to do the hard jobs of peacetime production.

Any fastening problem you anticipate will be welcomed by our engineers. They are ready to help you solve it and recommend the proper Elastic Stop Nut.

LOCKED ON THE BOLT BY THE ACTION OF THE GRIPPING RED COLLAR.
THE COLLAR IS ELASTIC. THE NUT CAN BE USED TIME AND TIME AGAIN.
MADE IN ALL SIZES AND TYPES—WITH THREADS TO FIT ANY STANDARD TYPES OF BOLTS.
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ELASTIC STOP NUTS
Lock fast to make things last
UNION, NEW JERSEY AND LINCOLN, NEBRASKA